Journal of SOIL and WATER CONSERVATION

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JOURNAL OF SOIL AND WATER CONSERVATION

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SOIL CONSERVATION SOCIETY OF AMERICA

WALTER C. GUMBEL, *Editor*

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EDITORIAL

About the Journal

THOSE responsible for a new publication are always beset by a certain amount of anxiety, and even apprehension, about the reception their efforts will receive. So it is with this JOURNAL. The editor, and those who have worked with him on this first issue, have tried to gauge—and to satisfy—the wishes of a majority of the members. This has not been easy. Much that we had hoped to do did not get done. Improvements that can be made in future issues are already apparent. These we shall make, as well as others that will be suggested as future issues succeed each other. The JOURNAL belongs to you; we ask that you regard it so and give it the attention you would give any other piece of your personal property. Specifically, take the time to let the editor know what you like, and what you do not like, about the JOURNAL.

A few words concerning our own ideas about what the JOURNAL should be, and do, are in order. First, we believe the JOURNAL should represent the Soil Conservation Society of America. Secondly, it should present, with each succeeding issue, the latest and most authoritative information about the science of soil and water conservation, and the principles of sound land use. It should be practical. It should be easy to read. It should be stimulating. It should actively champion the cause of soil and water conservation. It should above all, be useful.

The pages of the JOURNAL will not be a source of delight to the dilettante. On the other hand, we do not subscribe to the notion that professional soil conservationists prefer their reading couched in stilted, scientific jargon, or interspersed with the maximum number of tables and graphs. We shall try to keep the JOURNAL on a course that is neither superficial nor pedantic. Let it be as constructive and as alive as the science we seek to advance.

World Peace Through Soil Conservation

ELSEWHERE in the JOURNAL reference is made to a statement by Sir John Orr in which he points out that methods of controlling soil erosion should be followed in every corner of the world as a basis for preventing famine. This would apply especially to countries that have long exploited their land resources and are continually confronted with the problem of food shortages. The destruction of the land destroys the economic independence of nations. It creates a problem of international concern.

Great quantities of food grown in the United States on land protected against soil erosion are being shipped abroad to famine stricken people. This is as it should be. Famine is an annual occurrence in many parts of the world, while in others it is temporary due to conditions resulting from the war. The question arises as to the advisability of continuing to provide food for countries that continue to deplete their soil resources. Should assistance be provided through the United Nations for the application of a long-time soil conservation program? The answer points to conservation as a sound and practical approach.

A soil conservation program, when well established, would result in increased production of food, and at the same time secure the land. It would also help to restore the economic independence of the people and the nations

(Continued on page 38)

Why Another Society?

RALPH H. MUSSER

RALPH H. MUSSER is president of the Soil Conservation Society of America. He also holds the position of Regional Conservator for the Soil Conservation Service at Milwaukee, Wisconsin.

WITHOUT GOING into the underlying reasons, it is now abundantly clear that conservation of soil and water resources has become one of the prime objectives and one of the major fields of sustained endeavor in our country. The development of soil conservation thought and knowledge in recent years has been nothing short of phenomenal. Action on the farms and watersheds of the nation has been a most fortunate corollary.

In hundreds of soil conservation districts, on thousands of farms and ranches, in schools and universities, in research stations, in business concerns, and in government, men are turning an increasing share of their attention to the ways and means of protecting irreplaceable soil and water resources. What we are witnessing today, however, is only a beginning. As the years go by, the urgency for soil and water conservation will become ever more compelling. Clearly, too, its application will become more exacting.

Outside of the United States, interest in modern conservation technology is also mounting steadily. No special vision is required to forecast that it will continue to grow. Inevitably, in nation after nation, this interest will be translated into action. Mankind's twin yearning for survival and improvement dictate such a course.

At the core of this great endeavor to hold on to the world's store of productive soil and water, will be the professional soil conservationist. His will be a multiplied responsibility. On him we must depend to point the way; to stipulate the time and place of conservation action. On him we must depend for the scientific verity of the work itself.

Under these circumstances, it became a natural and necessary step for soil conservationists to seek the greatest possible degree of unity and agreement among themselves on professional standards, as well as on scientific objectives. In turn this called for organization.

Nowhere within the framework of existing learned societies, however, was there sufficient opportunity or encouragement for the fruitful advancement of the science of soil and water conservation. This, in itself, was not surprising. Other societies, distinguished in their separate fields, had been organized for other interests and other purposes apart from soil and water conservation. Each served a worthy purpose. To accommodate itself to the needs of professional soil conservationists, any one of the existing societies would have had to broaden or contract its prevailing scope.

Plainly, the situation required a wholly new society. Professional soil conservationists numbered in the thousands. They had no common meeting ground, no medium for joint expression, and no unified strength for advancement.

Out of these conditions, the Soil Conservation Society of America was born in Chicago on November 11, 1941. Nearly two years elapsed, however, before the founders were ready to proclaim its formal organization on September 1, 1943. At that time temporary officers were elected and qualified persons were invited to membership.

Today the membership has passed the 1,700 mark and is increasing steadily. There are 14 active chapters of the Society and other

groups are petitioning for chapter status. In Canada as well as other countries in the hemisphere, interest and membership in the Society are growing. The Society's program is rapidly taking on form and dimension through the work of individual members, committees, and chapters.

The Soil Conservation Society expects to reach not only persons professionally engaged in practicing or teaching soil and water conservation, carrying on research in the field of soil and water conservation science, or participating in the administering of these activities, but also those who have been previously engaged in the above activities, as well as scientists or technicians in closely allied fields and other persons whose work and interests have furthered soil and water conservation in a substantial manner.

The Society plans to promote and advance all phases of the science of conservation of soil and water and recognize the related fields in the promotion and advancement of the science. As I see it, there should be no conflict between the Soil Conservation Society and any other professional societies or organizations seeking to advance or promote interest in soil conservation. The objective efforts of these organizations should complement each other.

In the months and years ahead, our work will be cut out for us.

We shall undertake to stimulate, collect, and put to use the best scientific thought, in and out of government circles, on soil and water conservation.

We shall undertake to present the professional soil conservationists' point of view, whenever that seems advisable, to the public, to appropriate branches of government, and to other societies.

We shall undertake to evolve certain professional standards, as guides, for the conduct of soil and water conservation work.

We shall provide a friendly forum to professional soil conservationists, for the presentation and exchange of useful observations and experiences.

We shall foster constructive debate on pertinent matters of interest to professional soil conservationists.

We shall encourage soil and water conservation research along all rewarding lines, but particularly along those which promise tangible improvement, on a practical basis, in farming methods.

We shall encourage soil and water conservation education, formal and informal, wherever an increased understanding of soil and water resources will be beneficial.

We shall undertake to recognize especially meritorious contributions to the science of soil and water conservation.

We shall undertake such other actions, as may be presented in the course of time, which promise to further the science of soil and water conservation.

And most important, we shall undertake to guide and improve the science of soil and water conservation to the end that it will serve mankind in the greatest possible degree.

The Soil Conservation Society of America begins its work at a propitious hour in history. Throughout the world there is a vast popular surge for a break from the exploitations of the past, for security, and for improvement in the standard of living. There is simultaneously a growing recognition of the value of natural resources and of the vital role they will play in shaping our future. Science itself is assuming a more prominent and a more practical role in everyday affairs. These are all hopeful, progressive signs. They provide an environment in which we may serve, usefully.

Land Drainage in Great Britain

E. W. GAIN

DURING THE CRITICAL period in the Battle of the Atlantic, E. W. Gain, drainage engineer, was loaned by the Soil Conservation Service, through the Office of Foreign Agricultural Relations, to the British Ministry of Agriculture. Arriving in Great Britain in July 1942, he spent 2½ years on essential war-time undertakings, making complete drainage investigations and inspections, and assisting local technicians in an advisory capacity.

IN FUTURE historical accounts of the "Battle of Britain," British agriculture deserves its full share of glory. Under five trying years, it accomplished the colossal task of raising domestic food production for some 47 million people from a pre-war low of one-third to more than two-thirds of their total requirements. This involved conversion of four million acres of grass and waste lands for tilled crops and required not only a complete change to tractor-drawn ploughs, application of vast quantities of commercial fertilizers, but also rehabilitation of thousands of existing agricultural drains and construction of many new drains.

This vast expansion of drainage improvements placed as unprecedented heavy burden on the Ministry of Agriculture and Fisheries. Due to losses of technical assistance to the armed forces and war industries, Ministry engineers and local drainage boards were greatly handicapped in dealing with special engineering problems constantly arising that required detailed investigations and application of reasonably complex hydraulic knowledge and experience. An appeal was made to the President of the United States for assistance and services of several Soil Conservation Service technicians were made available.

To American engineers, accustomed to drainage problems characteristic of a continental climate and large land masses, conditions were strange. The weather is typically insular and varies conisderably from year to year without seasonal regularity. It has been said that over the course of a year the sun is seen about a third of the time it is above the horizon, and during the winter months, unless aided by wind, it seems never to rise high enough to dispel prevailing haze and fogs. Summer temperatures are about 15 degrees lower than those of our eastern states and, due to the Gulf Stream, about as much warmer during winter. There are no clearly defined rainy periods. Rainfall is inclined to be uniform throughout the year and, while total annual precipitation is about the same, intensities are not nearly so great as in the States. There is definitely smaller surface runoff in proportion to total rainfall to be taken care of. Probably the only reason that greater runoff can be expected during winter months is that colder temperature and more consistent cloud cover reduce evaporation losses and little moisture is absorbed by dormant plant life. On the other hand, a considerably greater amount of underground flow reaches outlet channels. Consequently, there is far less fluctuation from average flow in English streams than might be expected in those of the States. This has made possible considerable regulation and bifurcation of channels for water power and supply through past centuries without great risk from floods, and thus alterations to many of these channels for benefit of agriculture without damage to other improvements is often difficult.

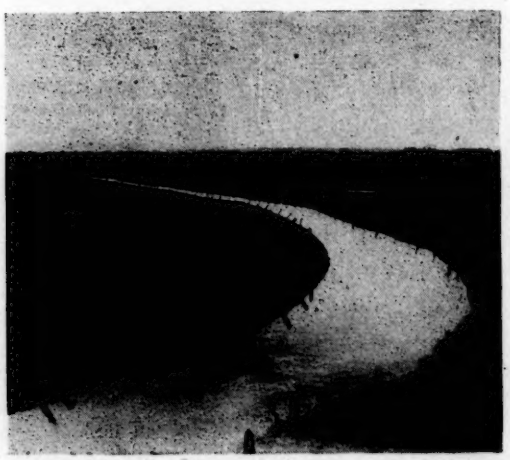
Mute evidence of the freedom from frequent heavy and intense rainfalls, heaving action of frost and excessive shrinkage of drought is shown in hundreds of miles of

roads completely without or having only small side ditches.

Land drainage is one of the oldest agricultural practices in England and was probably introduced by the Romans during their occupation, when large areas were marsh and bog. It has been estimated that over four million of the 30 million acres now in agriculture are dependent on arterial drainage by the main rivers and their tributaries. An additional 2½ million acres not affected by such channels, as upland areas, require supplemental drainage.

The Romans are believed to have undertaken the first major drainage and flood control works, although no records are known dealing with such work. Parts of the "Roman Bank" still exist along the coast of Lincolnshire, where it is apparent they attempted to prevent flooding of the Fens by the sea. Likewise a 60-foot channel connecting the Rivers Nene and Witham was believed to have been cut by them as a means of diverting highland water away from the Fens. Over the centuries extensive marsh areas, low lying moors, and mud flats have been reclaimed for agricultural use. Early drainage of some of these areas was effected largely by construction of enclosing embankments to prevent inundation, which in some cases occurred only at period of high spring tide. Internal drainage was carried by enlarged natural channels, through sluices, into the sea. Some of these improvements have not been altered materially since construction centuries ago and present day rehabilitation requires only sluice repairs and clean-out of internal ditches.

Earliest known drainage legislation occurred in the 13th Century in connection with the Romney Marshes of southwestern England, setting up laws and customs still existing today for administration of drainage works. The famous Statute of Sewers of 1531 provided for a commission whose powers were limited to appraising and bringing about a remedy for defective drainage. Not until 1833 was legislation passed to provide these commissions authority to carry out improvement works themselves. By 1861 other types of drainage authorities were established, but none with respect to any long reaches of main arterial rivers. Drainage works as required in the Great Fens makes essential inclusion of entire watersheds under a single authority for effec-



River Perry, Shropshire, February 1943, showing derelict lands adjacent.

River Perry, June 1944, following excavation based on improvement plans. The spoil leveling is incompleted.

Saint Germans pumping plant, draining 180,000 acres of the Great Fens.

A small government-owned dragline with side-arm attachment for excavating field border ditches.

tive control. It was recognized 50 years ago that there was a distinct need for overall administration, as there were 361 various authorities within England and Wales without uniformity in methods of control or cooperation, even between adjacent authorities on the same river. As a result, the Drainage Act of 1930 establishing Catchment Boards came into being, giving them authority for supervision and control of all watercourses entering a main river, but limiting the undertaking to their established main channels, covering flood control improvement, channel maintenance, and embankment works for shore protection and coastline defences. Maintenance of smaller channels was left with local county councils. Revenue for administrative and engineering work of Cachment Boards is derived from assessment against annual revenue of local county and urban bodies, from which all agricultural land has been exempted. Direct Government grants for improvements makes it possible for many Boards to function in rural areas with small tax income. Fortunately, by the beginning of the war they had already accomplished much effective work, particularly in clearing of extensive reaches of river affording outlet for thousands of smaller laterals and field drains.

The Great Fens of Cambridgeshire and Lincolnshire are the most extensive reclaimed areas and have provided England with its most fertile croplands. They consist of areas of silt adjacent to the sea and peat lying to the inland. In the 17th Century extensive drainage was carried out under the famous Dutch engineer, Vermuyden, who excavated a system of channels through the Fens to the sea. Drainage improvement and cultivation gradually settled the peat lands so that the lowest land was farthest inland. Likewise, variation in settlement developed and the outlet rivers soon required supporting embankments to keep them within their course. With gradual lowering of the land level below the bed of the outlet channels, great wind pumps, so familiar in Holland history, were established to raise water from the internal drains behind embankments into the outlet rivers. A few of these still operate. Continued settlement, still in progress, made it impossible for these pumps to cope with increasing seep water and they were gradually replaced by pumps of larger capacity, first powered by steam, then by diesel driven units capable of removing ¼ inch of rainfall in 24 hours. Today these represent some of the largest and finest pumping plants in the world. During the war a large part

of the internal ditches have been cleaned and new pumps provided.

In some areas they are troubled with erosion of light soils by wind. In years past fields with silt and peat topsoils have been stabilized by "claying," a painstaking process of spreading clay over the surface and subsequently ploughing it under, thus binding the topsoil down. Drainage authorities, still troubled with areas where additional stabilization is needed, are considering willow and brush windbreaks.

There are many drainage problems still confronting these Fens, such as protection from infrequent floods from upper watersheds, occasional high tides and gales which prevent many sluiced outlets from discharging into the sea, and protection of eroding embankments along main drains.

While technical assistance was devoted principally to arterial channels and larger drainage works, the most intriguing work, due perhaps to the greater differences from American practices, was found in the field drainage, where frequent remnants of a long and historic past were evident.

The pattern of field drainage has been influenced as much by the manner of field enclosures as by topography. Whereas in the States nearly all field boundaries are more or less arbitrarily rectangular, with open fencing, the usual British boundary is irregular, fitting the land, and with closed fencing. It seemed that when enclosures developed from the common land of feudal times, boundaries followed either drainage ways, cultivated strips usually running up and down the slope, or natutal contours. While fields up to 100 acres are found in the fens or large river flood plains, the rolling country is usually broken up into small units of five to ten acres. Fields are commonly enclosed by thick hedges, although in some areas, such as the limestone area of Southwest England or the moors bordering Scotland, fences are constructed of stone flagging. In other sections, such as Cornwall and Devon, earth embankments are covered by sod or sometimes by stones wedged into the top and sides.

Since closed fencing often prevents good surface areation and obstructs free surface drainage, a system of field boundary drainage developed. This is the most common method of field drainage. It usually consists in a narrow ditch 2½ to 3 foot deep, with 1½ to 2-foot bottom and steep side slopes, placed against hedgerow or wall. Steep side slopes are maintained, since they become quickly covered by sod and are seldom scoured by torrential rains. Due to their small section, prolific growth of grass and rushes, and trampling by stock, they require continuous cleaning, which is usually done during winter months by hand labor.

In the flat lands, such as fens and moors, these ditches are larger and are used both for livestock watering and fence. Penstocks or stanks are placed across these ditches to maintain water in the channel during dry periods. While this practice may often be detrimental to underdrainage, it is frequently the only means of obtaining fresh water, since underground water even considerable distances inland is often saline and wells thus not potable. Post-war plans providing piped water to all agricultural areas may eventually reduce stanking.

Another form of field surface drain, particularly on heavy clay land, is the "Ridge and Furrow." This method apparently developed from the old feudal strip farm. In feudal days a serf farmed one or more allotments of land, each comprising a strip about 220 yards long and 11 to 22 yards wide, forming a plot a half acre or an acre in extent. A number of strips adjoined in a common ground of cleared land. They were separated by narrow borders of unploughed grass, with headlands or borders at their extremities, usually used as a roadway for plough or wagon. It

was from these furrows that the term "furlong," or furrowlong, developed. To improve drainage, each strip was placed up and down the slope. In cultivating these, there developed a tendency to place a trench or dead furrow on either edge with the soil mounded toward the center. Gradually a series of ridges and channels developed forming a corrugated surface running up and down the slope. Some farmers conceived the idea that these corrugations increased the surface area of the fields and consequently depths between furrows and ridges were often developed to an absurd degree. Some measurements indicate distances between furrows as varying from one to two rods and between ridge and furrow from 1 to 2½ feet. For centuries many of these ridge and furrow fields were maintained on heavy land for internal drainage, either by ploughing the dead furrow during cultivation or by protective grass cover when in meadow. These are seen in many parts of England, particularly on Shakespeare's Avon in the fertile Vale of Evesham, which has been continuously cultivated from Roman times. While such fields are satisfactory for pasture, the corrugations interfere considerably with powered tractors and multiple-bottom ploughs and it is quite likely that many will soon disappear.

Closely related to the "Ridge and Furrow" principle, and similar to what is termed "Bedding" in the heavy soils of the States, are "Grips." These are shallow ditches found in the reclaimed mud flats or warped land adjacent to the sea, where the soil is heavy and used for hay and pasture. "Grips" are nothing more than dead furrows systematically cut across the field at intervals varying from ½ to 2 rods and depths varying from about nine inches at the center of the field to about 18 inches at the field border ditches. Maintenance was usually by hand labor, although a small tractor or horsedrawn trenching plough, consisting of a flat horizontal cutting blade between two parallel colter wheels, was seen used in South Wales.

Underdrainage installations, with some modifications, are essentially the same as those in the States. However, occasional examples of the predecessors to existing practices were found. An earlier type consists of narrow slit trenches filled with gravel and brush, or often with a bit of sod turned upside down in the bottom and arched against one side of the trench wall to form a small conduit under the refilled soil. These gradually developed into brick or stone conduits, usually laid as random drains along hollows and low areas of fields to an outlet stream. Stone drains, consisting of two parallel rows of stone blocks covered by stone slabs, were seen in the Cotswold areas of Gloucestershire and in South Wales. In many cases they were still found operating satisfactorily. Where stone was not available bricks were used. It is probably from this use of clay products that the pipe drain was later conceived. While the old flat-bottamed, horseshoe type clay pipes, used earlier in the States, have been abandoned in most of England, they are still produced in Scotland and a few Northern English counties.

Another type of field underdrain used extensively in heavy clay lands is the mole drain. These, used to some extent in the States, consist of artificial channels drawn through the soil by means of a mole plough. This method developed from the practice of plug drainage, wherein drains were made by placing a metal plug or strings of plugs in a narrow trench, tamping clay on top, and drawing the plug through so that a hollow earth tunnel was formed. In some instances the clay roof in these tunnels was pierced with rods to permit entry of water. Brush was placed over these as protection and for a percolation channel before the trench was refilled with earth. Earlier mole ploughs drawn by teams of horses were replaced around 1850 by steam tractors with winch and cable attachment. Since the war moling ploughs have been drawn by American crawler type tractors. The vertical

slit produced by the colter to which the steel mole is attached persists for years and during dry periods were observed to open, thus maintaining small drainage channels toward the mole even after it became plugged with silt. Moles are drawn at intervals of 3 to 5 yards and at depths of 18 to 24 inches. In ridged and furrowed land they are usually drawn in the furrows. Moles are quite often drawn directly into open ditches; however, since the outlet easily plugs up, better installations are outletted into a tile main, usually placed parallel with the open channel.

Most drains have been installed by hand by experienced drainers. They usually follow water grades up the slope. Lines laid by instrument are exceptional. Required pipe sizes are determined largely by judgment, and not by hydraulic capacity. "Minors," termed laterals in the States, are usually placed at shallower depths and closer spacings than found in American practice. Size of minors is smaller than those in the States, many being not more than two inches in diameter. Some of only one inch have been dug up. The present tendency is toward 3-inch minimum and 4-inch minors are encouraged on government schemes. "Mains" or outlets usually follow the course of the valley and are seldom more than a mile or two in length before discharging into an open channel. Pipe diameters seldom exceed 12 inches.

Due to labor shortage mechanical means for trenching, tile laying and cleaning ditches was begun during the war. A number of American tile trenchers and some 600 government draglines, in addition to other public and contract machines, were used. For use along boundary ditches where hedge growth restricted the casting of the dragline bucket, a side-arm bucket attachment which permits dragging of the bucket along the drain has been developed. A unique trenching unit known as the Roteho, installed on English Fordson tractors, and consisting of a rapidly rotating disc with hook-shaped cutters on the perimeter, has also been developed and extensively used.

British drainage engineers are confronted with many problems almost unknown in the States. These are, for example, conflicts with fishing interests who derive large annual incomes from fishing privileges and are opposed to dredging and changes in their channels which would disturb fish life; complex hydraulic problems arising from alterations to bifurcated channels leading to numerous weirs and sluice controls, the rights to which are legally established and privately controlled; and the legal principle established making Catchment Boards liable for any damage claims connected with work done on their main channels but allowing no compensation for improvements except where they include smaller drainage bodies still authorized to obtain improvement taxes. Laws to alleviate conflicting authority between water conservation, fishery and local health authorities regulating water supply and stream pollution are contemplated. In the thoughts of those intimately connected with land drainage there are not only extensive schemes for completing the regulation of arterial channels to suit them to modern needs, but also such other related problems as research on runoff and discharge studies, and university training for engineers to meet more specialized needs, from channel hydraulics, on the one hand, to the economics and physical effects of field drainage methods on agricultural production on the other.

Earthworms as a Factor in the Formation of Water-Stable Soil Aggregates

HENRY HOPP AND HOMER T. HOPKINS

HENRY HOPP and HOMER T. HOPKINS are soil conservationists in the Erosion Control Practices Division of the Soil Conservation Service and are located at the USDA Research Center, Beltsville, Maryland. The authors gratefully acknowledge the aid of Jay C. Bryant in making the aggregate analyses.

AT THE time that the national implications of erosion control became widely recognized, an investigation was undertaken by Middleton (5), to determine the properties of soils that influence their susceptibility to erosion. This study revealed that the dispersibility of soil in water was the most important single property affecting erodibility. At about the same time, workers in Russia, followed by Baver and Rhoades (1) in this country, pointed out that the dispersibility of soil is related to the cementation of individual particles into water-stable aggregates. In 1934, Lutz (4) concluded that water-stable aggregates are of basic importance in erosion control. Peele and Beale (7), in 1941, showed that the erodibility of soil can be modified by changing the degree of aggregation.

The significance of water-stable aggregation stimulated numerous studies to determine its cause. Root action, changes in soil moisture content, and physico-chemical relations were investigated. The view most generally accepted at present, however, is that proposed by Geltzer (2), in Russia. He concluded that cementation of soil particles into aggregates resulted from the production of sticky materials by microorganisms during the course of organic matter decomposition. Waksman and Martin (8), in this country, showed that organic matter caused soil aggregation only when microorganisms were present. Peele (6) extracted some of the sticky materials from certain bacteria and proved that these materials actually were capable of cementing soil into a water-stable form.

The emphasis on microorganisms has tended to divert attention from other structure-forming factors of the soil. Among these are the earthworms. Earthworms are known to ingest soil and excrete it in the form of pellets or aggregates. However, the water-stability of these aggregates and the rate at which they may decrease the dispersibility of soil are not known. It has recently been found that the earthworm population in agricultural land can be greatly changed by cropping practices (3). Information on the extent to which earthworms may contribute to the formation of water-stable aggregates is therefore timely.

Methods

A Christiana silt loam that had been cropped to Korean lespedeza and wheat for five years was collected and air-dried. The soil was ground and sieved to remove all particles larger than one-half mm. Seventy-five grams of this soil were then placed in each of 18 Petri dishes and moistened to 20 per cent moisture content.

Eighteen earthworms (*Helodrilus caliginosus* form *trapezoides* Duges.) from the same field were used in the experiment. They were washed and placed for one day in an extra container of similar sieved soil, in order to replace the soil in their alimentary tracts with the kind used in the experiment. Two worms

were added to nine of the Petri dishes and incubated at 25 degrees C. After four days, the earthworms were removed. The soil of each culture was then crushed lightly and the aggregates of three to five mm. diameter recovered by sieving. Two groups of aggregates were thereby obtained; one group formed under the influence of earthworms and whatever microorganisms were present, and another group formed under the influence of microorganisms only. Ten grams, moist weight, of the aggregates from each group were placed in twelve culture tubes, which were plugged with absorbent cotton, and treated in duplicate as follows:

Series	*Treatment*
A.	Air-dried immediately
B.	Incubated in a saturated atmosphere for 4 weeks
C.	Sterilized by autoclaving at 18 lb. pressure for 18 minutes; then incubated for 4 weeks
D.	Incubated in a saturated atmosphere for 4 weeks; then sterilized by autoclaving at 18 lb. pressure for 18 minutes
E.	Sterilized by adding 10 drops of toluene to each tube; then incubated for 4 weeks
F.	Incubated in a saturated atmosphere for 4 weeks; then sterilized by adding 10 drops of toluene to each tube for 3 days.

The purpose of the Series A cultures was to determine the stability of earthworm aggregates soon after they are formed. By means of the Series B cultures, any further effect of the native soil microorganisms on the earthworm aggregates was determined. Series C and D cultures were carried for the same period of incubation, but whatever microorganisms were present, were eliminated during this time by sterilization. Series E and F cultures were similar to Series B; but at the end of the experiment, they also were sterilized, in order to determine how the sterilization process affected aggregation.

At the end of the four-week period, all cultures were air-dried. The relative water-stability of the aggregates was determined by a modification of the Yoder method (9). With this modification, the aggregates that remained too large to pass a one-half mm. sieve after gentle agitation in water for two minutes, were recovered. Their weights are reported herein as water-stable aggregation.

RESULTS

After four days, the soil containing earthworms consisted partly of excreted casts and partly of broken lumps that had not yet been ingested by the earthworms. The soil that did not contain earthworms was compact and unbroken.

The water-stability of the aggregates in these cultures is shown in table 1. In four days, the aggregates from the cultures containing no earthworms were 4.47 per cent water-stable, while the aggregates from the cultures containing earthworms had become 15.68 per cent water-stable. Further incubation of the aggregates for a four-week period with whatever soil microorganisms were naturally present, but without earthworms, reduced their water-stability about two per cent.

Sterilizing with both steam and toluene had marked effects on aggregation. These treatments caused further cementation of the soil particles beyond that attributable to the microorganisms or earthworms. Apparently, this action was primarily physico-chemical. Notwithstanding, the aggregates from the earthworm cultures remained more water-stable than those from the no-earthworm cultures.

DISCUSSION

The rapid formation of water-stable aggregates in the earthworm cultures suggests that earthworms themselves were primarily responsible for the action. Upon further incubation in the presence of the native microorganisms of this soil, the water-stability of the aggregates did not increase. Apparently, the aggregates were water-stable at the time they were excreted by the earthworms, or shortly thereafter. There was no evidence that earthworm aggregates acquired stability over a

period of weeks as a result of stimulated microbial activity.

TABLE 1.—WATER-STABILITY OF AGGREGATES IN A CHRISTIANA SILT LOAM INCUBATED FOR FOUR DAYS WITH AND WITHOUT EARTHWORMS AND TREATED THEREAFTER IN VARIOUS WAYS.

Treatment of aggregates after initial 4 day period	Aggregates from cultures with earthworms	Aggregates from cultures without earthworms
	per cent	*per cent*
A. Air dried immediately	15.51	4.68
	15.84	4.26
B. Incubated 4 weeks	11.09	2.26
	13.69	2.66
C. Autoclaved, then incubated 4 weeks	16.70	14.77
	17.17	10.43
D. Incubated 4 weeks, then autoclaved	27.15	26.89
	31.65	27.45
E. Sterilized with toluene, then incubated 4 weeks	21.42	15.26
	24.16	14.79
F. Incubated 4 weeks, then sterilized with toluene	23.11	11.88
	19.15	16.16

Actually, incubation of the cultures for four weeks resulted in a loss of water-stability. The aggregates degenerated slightly during this time.

The purpose of treatments C to F was to test aggregation with micro-biological activity held in check. The results were not in accord with expectations, since both methods of sterilization evidently caused partial cementation of the soil.

Mention should be made of the fact that not all the aggregates from the earthworm cultures were casts. The aggregates were obtained by sieving, and included all granules of the three to five mm. size. The water-stability of pure casts would presumably have been greater than that of the whole soil, which consisted only in part of casts.

SUMMARY

In laboratory culture tests with an unsterilized field soil, aggregates formed by earthworms in four days were several times more water-stable than those formed without earthworms. The stability of earthworm aggregates was not increased by incubation for a subsequent four-week period.

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Ever so often, you hear or read about someone who attributes our high standard of living to our system of government. Conservationists are not so sure about that. They are inclined to believe that exploitation of natural resources from the richest continent on earth had something to do with it. And they are inclined to wonder how long the standard of living can be maintained without a sharp trend toward conservation. Even the earth has its limits. It is hard to believe that any system of government, no matter how free or regulated, would of itself bring a high standard of living in, for example, the Gobi Desert.

Conservation—A Coming Anti-Famine Measure?

CONSERVATION scientists everywhere will endorse the remarks of U. S. Secretary of Agriculture Clinton P. Anderson and Sir John Boyd Orr, Director General of the Food and Agriculture Organization of the United Nations, during the course of an NBC broadcast on June 15, 1946.

Toward the close of this program, Secretary Anderson referred to the sharply increased agricultural production in the United States during the war. As reasons for the increase, he listed "increased mechanization, scientific farming methods—crop rotation, contour cultivation—better crop varieties, better livestock strains. . ."

Then came a significant statement by Sir John Orr. He said:

"You Americans have the know-how. You ought to export that know-how. Your methods of controlling soil erosion, for example, ought to be followed in every corner of the world."

Anderson: "Yes, we discovered a dozen years or so ago that we couldn't continue to produce even enough for our own needs unless we dealt with the soil erosion problem. We know now that it can be licked, and we know how to do it."

Orr: "But some other countries—China, for example—have more serious erosion problems than this country ever had. They need your help."

Anderson: "Of course, Sir John, your Food and Agriculture Organization is supposed to spread technical information of this sort. We will certainly work with you. We've already sent experts in preventing soil erosion to South Africa—where it's a very serious problem—and to the Republic of Colombia and other countries—at their request. We recognize that the world will never be able to produce plenty of food if the soil is wasted."

Sir John Orr's expressed belief that United States methods of erosion control should be extended world-wide may become a memorable statement. It is the first public expression of its kind by a responsible official of the United Nations. If it portends an active interest by the FAO in furthering the application of scientific soil and water conservation throughout the world, we may even now be on the threshold of mankind's greatest effort to date to protect the Earth's remaining productive lands.

Aspects of Protecting Storage Reservoirs By Soil Conservation

CARL B. BROWN

CARL B. BROWN is Head of the Sedimentation Section of the Soil Conservation Service, Washington, D. C., and is the author of numerous bulletins and papers pertaining to the general subject of sedimentation.

IN OCTOBER 1945, the Corps of Engineers, United States Army, made public a list of flood control and river improvement projects, already authorized by Congress, on which designs were to be ready for initiation of construction by the late spring of 1946. The estimated total cost of these projects is $1,500,000,000. Many additional projects are under investigation. The United States Bureau of Reclamation has proposed a post-war program of 236 irrigation and multiple-purpose projects in 17 western states estimated to cost approximately $3,000,000,000. Forty of these projects have already been authorized by Congress.

More than 75 per cent of the expenditures proposed by these two agencies will go into construction of flood control, irrigation and multiple-purpose reservoirs or works directly dependent on such reservoirs. Eliminating some duplication in their programs, but adding proposed reservoir developments by municipalities, power companies, semi-public agencies, etc., it appears likely that the next two decades may witness the construction of nearly 5 billion dollars worth of major reservoirs and appurtenant developments. This would approximately double the nation's investment in projects of this type.

Already storage reservoirs furnish one-third of our electrical power, the water supply of one-fifth of our population and one-half of our industry, support a major part of the irrigated agriculture of 17 western states, and protect 6 million persons and untold billions of dollars in property values from flood hazards.

The former Secretary of the Interior, Mr. Harold Ickes, pointed out recently that the United States has become a "have-not" nation with respect to a considerable number of critical mineral resources. We are just as rapidly becoming a have-not nation with respect to sites for major reservoirs. If the contemplated public and private reservoir construction programs are carried out, we shall have utilized by the end of this generation a very substantial proportion of all the major reservoir sites which we can afford to utilize, or which now appear economically feasible for development. Indeed, many persons already have raised the question as to whether we can afford to take out of agricultural production such a vast area of highly fertile valley land (Class 1 land) as will be flooded by these developments. In any event, there is a very definite limit to the number of feasible sites for major reservoirs. These sites are all we have. We cannot discover new reserves, as we will of oil. Nor can we grow new reserves, as we can of forests. To whatever degree we conserve the capacity of the reservoirs built on these sites, to just that degree shall we conserve this indispensable base of our national strength and prosperity.

Atomic energy some day may supplant the electrical generators at our great power dams, but no scientist has yet foreseen any way in which it can dissipate destructive floods, conserve water for irrigation and domestic uses or afford us the relaxation with boat and fishing rod that may keep us sane enough to control atomic power.

Silting of our storage reservoirs has been widely publicized during the past ten years. It has been talked about in Congress, written about in the public press, made the subject of numerous reports, articles and speeches by so-called Government experts. Last year its critical importance was formally recognized by the American Society of Civil Engineers which created a Joint Committee on Sedimentation in Reservoirs. Nevertheless, there is still a great deal of misunderstanding about reservoir silting and about how it can be controlled. Our purpose here is to try to clear up some of this misunderstanding with particular references to what soil conservation practices on reservoir watersheds can do and cannot do—and to what extent they are economically justified in the solution of this problem.

The practical aspects of this subject can be grouped under five major headings:

(1) The rate, character and sources of sediment production from the watershed.

(2) The effect of the so-called capacity-watershed (C/W) ratio on the rate of silting.

(3) The relative value of dam sites as determined by their abundance and demand for the services which their utilization can produce.

(4) The economic pressure of the discount rate in computing benefits from sedimentation control.

(5) The time required for application of soil conservation practices, the costs involved and results to be expected from watershed treatment.

Let us look at these factors individually and then consider their interaction on one another.

RATE OF SEDIMENT PRODUCTION

Limiting values for the rates of sediment production in most major regions of the country have been fairly well established by reservoir surveys and by sampling the suspended

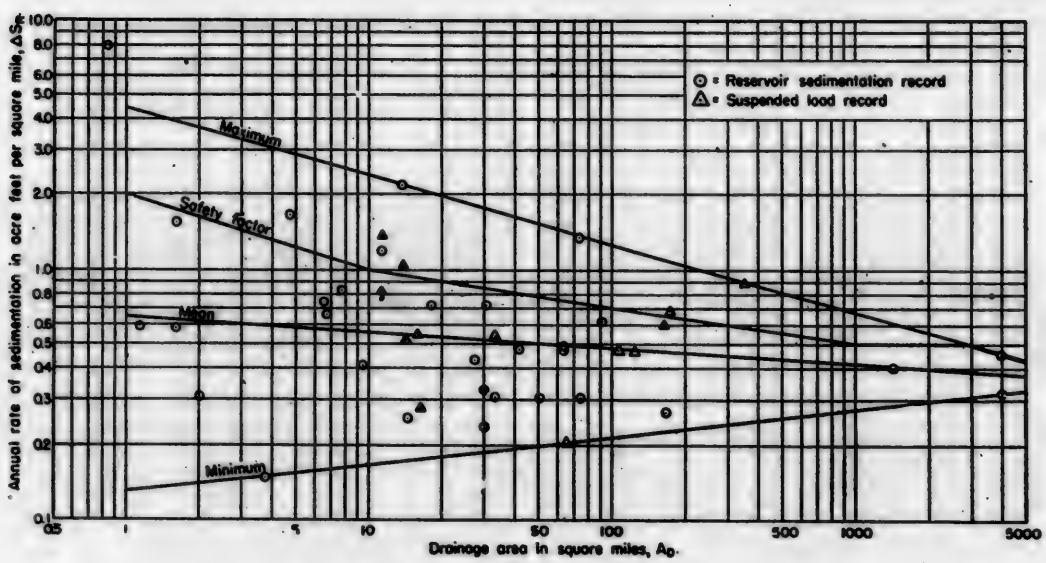

FIGURE 1

Relation of Rate of Sediment Production to Size of Drainage Area.

sediment load of streams. Figure 1 shows all of the reliable data for the Southern Piedmont. The annual sediment production per unit of area is plotted against watershed area. Two significant deductions may be drawn from this graph. (1) The smaller the watershed the greater is the range in rate of sediment production. This is to be expected because the contrasts in soil, slope and land use become greater as the watershed becomes smaller. If the chart extended into the range of plot data the spread would be very much greater yet. The larger the watershed the more conditions are equalized. In the range of moderate size watersheds—from 10 to 100 square miles—the variation is about ten-fold —from 0.2 to 2.0 acre-feet per square mile. If the individual records plotted on this graph were entirely comparable—if they covered the same period of years and included the total sediment load—the spread would probably be smaller. (2) There is a decline in both the maximum and mean rates of sediment production as the watershed becomes larger. This is interpreted to indicate a progressive dropping out of sediment by deposition on floodplains, in upstream reservoirs and lagging of the coarse or bed load material in the course of transportation downstream.

We need a great deal more data to plot satisfactory curves of this type for all sections of the country and to refine the curves for every section. But if one is familiar with the watersheds from which these data come, a reasonably reliable estimate can be made, by comparison, for other watersheds in the region.

The character of sediment as well as the absolute rate of production is important. The higher the percentage of coarse or bedload sediment—sand and gravel—the faster is the settling rate and the greater is the percentage trapped in a reservoir, other factors being equal.

Closely related is the question of sources of sediment in a watershed. The rate of sediment inflow to a reservoir depends not only on the rate of erosion of the land slopes, but also on the capacity of the stream system of the watershed to bring the erosional debris down to the reservoir. In some watersheds nearly all slopes lead down to well-defined channels which coalesce into the major drainage system of the area. The channels have grades and capacities sufficient to allow the streams to transport out of the watersheds almost the entire amount of all types of sediment eroded from the land slopes during any given period of precipitation. In other areas —and this is more generally the case—a substantial proportion of the erosional debris is deposited on alluvial fans and floodplains or as colluvium and on the lower slopes of fields because of the lack of continuity of channels or because the channels lack capacity to carry off flood flows without extensive overflow and consequent sediment deposition. Furthermore, there is commonly a time lag in the movement of the coarser sediment or bed load through the channel system. In some areas the channels themselves produce large quantities of sediment.

The techniques now used for measuring erosion in relation to agriculture, whether by plots or surveys, are not in themselves an adequate basis for judging the rates of sediment production from the watershed or the quantitative importance of the various sources of sediment. Methods are being developed, however, for accomplishing this objective.

There is an important corollary to this conclusion. If our techniques of measuring and evaluating erosion with relation to agriculture are not adequate for determining the sources of sediment, the programs of erosion control based on these techniques may fail to accomplish the desired degree of reduction in sediment inflow to the reservoirs or may lead to excessive costs for a treatment program aimed primarily at reservoir silting control. The essence of successful control of sediment inflow to a reservoir by watershed treatment is, first, to determine the quantitative import-

ance of various sources of sediment and, second, to design a program that will prevent the production of—and control the movement of, sediment from these sources.

CAPACITY—WATERSHED RATIO

Let us consider now a relatively simple but frequently overlooked aspect of the problem—the relationship between the capacity of a reservoir and the size of its watershed. This has an important bearing on the rate of silting—and particularly on how silting can be controlled.

Figure 2 shows the effect of the capacity-watershed (C/W) ratio on the annual storage loss for an assumed annual sediment production of one acre-foot per square mile of drainage area. Let us imagine a watershed of 100 square miles. If all of the sediment inflow were trapped by the reservoir regardless of the reservoir's size, the rate of silting could be read from Curve A. For example, if we built a reservoir with 1.0 acre-feet of storage the C/W ratio would be 100 and the annual silting rate would be 100 per cent.

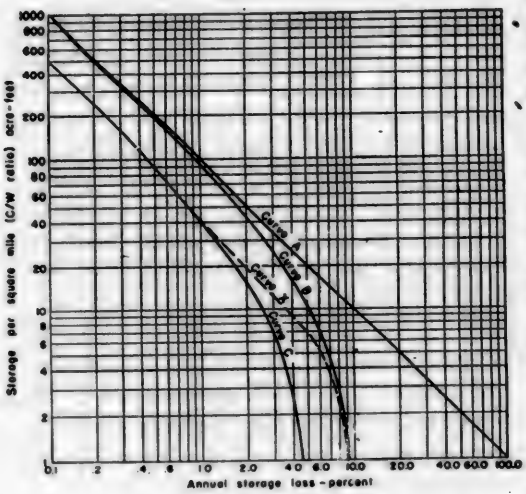

FIGURE 2

Relation of rate of storage capacity loss to capacity-watershed ratio.

Actually, the smaller the C/W ratio the smaller will be the percentage of the total sediment inflow deposited in a reservoir during its life history. The percentage trapped is a function of several factors such as reservoir shape, sediment characteristics, manner of operation of the reservoir, etc., in addition to the C/W ratio. But from a practical standpoint, the C/W ratio is generally the controlling factor. It is always a readily determinable criterion. It also indicates the physical possibilities for silting control.

If we assume an average trap efficiency coefficient in the foregoing example, the actual rate of silting would be shown by Curve B. This curve bends down because the smaller the C/W ratio, the smaller is the percentage of sediment trapped. If we built a reservoir of 300 acre-feet capacity, which would have a C/W ratio of 3.0, the annual rate of silting would be 7.7 per cent, whereas, if all the sediment were trapped it would be 33.3. This is, of course, an average over the life of the reservoir, and the percentage applicable in any particular year.

Now, if we could cut the rate of sediment production from the watershed in half by soil conservation measures, and keep the other factors constant, we would halve the rate of silting as shown by Curve C.

Unfortunately, we cannot keep the other factors constant. What is being done predominantly, through the soil conservation district programs is to reduce the proportion of fine sediment—the so-called "wash load," which is carried in suspension in the runoff water from the field to the reservoir during a single storm period. We do not materially affect the rate of movement of coarse bedload material toward the reservoir in any short period of time, because the bedload moves down the drainage channels intermittently as a function of stream discharge. It may require many years to move from its source in the field gully to the downstream reservoir.

Stabilizing the gully today does not affect the movement of material eroded years ago.

It is true that the bedload movement can be arrested by channel control works such as drop structures and debris barriers but the value of the reservoir with a low C/W ratio is seldom sufficient to justify the costs of such works.

Most of the sediment deposited in reservoirs of low C/W ratio is bedload material. The fine wash load, which our present conservation program is reducing materially and proportionately much more than bedload, mostly passes over the dam. In general, therefore, we are forced to conclude that reservoirs of low C/W ratio will not be protected by the soil conservation districts programs because: First, these programs do not rapidly reduce the bedload inflow, which primarily causes the silting; second, such reservoirs are silting rapidly and the time available to protect them is too limited with respect to time required for application of control measures; and, third, the value of such reservoirs does not ordinarily justify supplementary control works which would retard bedload movement. The probable actual effect of our present control programs is indicated by Curve X.

Before leaving this aspect, we should stress that information coming from the field indicates that reservoir owners and soil conservationists are being misled rather frequently on the possibilities of controlling silting in low C/W reservoirs through the work of soil conservation districts. Our research has gone far enough already that we can quite generally predict the relative chance of affecting the rate of silting by a conservation program if we know the location, age, use, capacity and watershed area of any reservoir.

RESERVOIR SITES

Sites for some types of reservoirs are much scarcer than for other types. For example, reservoirs created by Boulder Dam, Grand Coulee, Fort Peck, Norris, Elephant Butte, Roosevelt and San Carlos all utilize unique sites. True, additional storage can be developed somewhere on most of these streams at one or more additional sites, but usually at much higher unit cost. The loss of any one of these storage basins would cause very serious, if not irreparable, social and economic dislocations.

At the other extreme are stock ponds. On most larger tracts of land there are numerous available sites. True, the best ones are usually picked first, but generally alternative sites can be developed over a long period of time. Even municipal water supply reservoirs, particularly in the humid regions, may generally be placed at several alternate sites although usually the best and cheapest site is used first. This leads to the general conclusion that we cannot afford to spend a great deal more to protect a stock pond than it would cost to build another one at an almost equally favorable site. We can spend relatively more to protect a municipal reservoir because of the relatively higher differential in future successive replacement costs and importance of services. But for our major power, irrigation and flood-control dams, we often have little or no choice of replacement. They represent the utilization of a resource that is irreplaceable, and they render a service that is non-substitutable. What can we afford to protect them?

DISCOUNTING FUTURE BENEFITS

The life expectancy of dams also enters this picture. If stock ponds are built with spillways designed to pass storm runoff having an average recurrence interval of once in 25 years we are hardly warranted in trying to protect them against loss by silting for 100 years. On the other hand, the spillways of our major dams are designed to pass the greatest possible flood, for their failure would be catastrophic.

The site factor is partly one of physical availability and partly one of the economics

of utilizing the site. There is also a purely economic factor — the effect of the discount rate in computing the present worth of deferred benefits. Perhaps this can be best explained by an example. In the flood control survey of the Trinity River watershed, Texas, made by the Department of Agriculture, economists computed the benefit to Bridgeport Reservoir from a conservation program on its watershed. This reservoir was completed in 1934 on West Fork of the Trinity River by the Tarrant County Water Control and Improvement District No. 2. It provides municipal water supply for Fort Worth, controls floods, regulates stream flow and provides recreation. Its total cost was $2,317,000. The proportional cost of the conservation storage of 292,000 acre-feet was estimated to be $829,000. The loss of conservation storage capacity, shown by a sedimentation survey, is 0.27 per cent annually. The annual sediment production from the watershed is near average for this region—0.75 acre-feet per square mile annually—but the C/W ratio is 278, which accounts for the small rate of storage loss. It was estimated that the useful life of the reservoir, except for flood control, will be ended when 70 per cent of the conservation storage capacity is exhausted. This will occur in 242 years from 1940 at the present rate of silting. The cost of the original storage was $2.84 per acre-foot. To replace this storage at one or more additional sites to provide the same service, was estimated to cost $17.50 per acre-foot or $3,462,533. Assuming that a sinking fund could be invested with safety at 3½ per cent interest for 242 years, we would need to place only $29 annually in such a fund to provide for the replacement at the end of 242 years. Or, put another way, the value of $3,462,533, to be spent 242 years hence, is at present only $831, discounted at 3½ per cent. According to this method of evaluation $831 is all that we can afford to spend today on the watershed of 1,051 square miles even if we could entirely prevent silting in this reservoir. Or we could spend $29 per year for 242 years if that would do a better job.

The time required for application and full effectiveness of soil conservation practices is an important aspect of the problem. That the time varies with the size of area to be treated, is obvious. Even with ample funds for technical planning, it would take perhaps 50, perhaps 100 years to complete the soil conservation job in all its aspects throughout the Nation. The process requires education of the landowners, training of numerous technicians, planning all the farms, growing all the seed, manufacturing all the equipment. Furthermore, there is a time-lag in the effectiveness of various practices. While terraces may be fully effective the first year, kudzu may not blanket an area for three years or more, and tree planting may not produce a fully effective litter for six or eight years.

For a given area of one square mile facilities might be ample to complete a fully effective conservation job in one to five years. For an area of ten square miles the time might be three to seven years, for 100 square miles five to ten years, for larger areas 10 to 20 years, or more. In the flood control survey of the Trinity River Watershed, Texas, it was estimated that the programs of soil conservation districts would develop cooperation from 61 per cent of the landowners on the 12,900 square miles survey in 50 to 70 years. With an added subsidy from a Flood Control program it was estimated that this degree of cooperation could be achieved in 15 years. The significance of this factor comes in establishing the economic justification for reservoir protection. We must allow for the time-lag in completion of a fully effective program.

Furthermore, as is obvious, the cost of in-

(*Continued on page 43*)

A National Program of Soil Conservation

HUGH H. BENNETT

DR. HUGH H. BENNETT is Chief of the Soil Conservation Service, USDA, and is recognized throughout the world as an authority on soil erosion problems. This article presents his estimate of the factors essential to a national soil conservation program.

PEOPLE HERE in the United States — and in many other countries — are learning that we must have soil conservation if we are to have continuous, abundant agricultural production. We are fast learning, too, that it must be effective conservation — the kind that will keep our land permanently productive.

Effective soil conservation is a result of intelligent use of the land resource. This may mean contour cultivation and terracing to hold soil and conserve rainfall. It may mean seeding grass or planting trees to meet the needs of bare, steep slopes or of shallow soil overlying rock. It may mean grass or surface mulch to protect fields from wind erosion. It may mean changing a rotation to increase soil productivity, and so on.

Productive land — which all of us, city and country people alike, live from — is our Nation's most important resource. It is indispensable to the welfare of every one of us. Industry and labor, and professional people, as well as farmers, have an all important stake in the country's good land. People today are all rightly concerned about America's indispensable resources of land and water; they have come to realize as never before that these basic assets are inseparably linked, directly, to the present welfare and future security of the United States.

These same resources also have critical bearing on the future of civilization. Food — which comes from the soil — was an important weapon in the war and it is important in the peace — at all times.

Productive land, therefore, is our base; for everything we do, all we share, even whatever we amount to as a great people, begins with and rests on the sustained productivity of our agricultural lands.

Program In The United States

Thirteen years ago (September 19, 1933) the first comprehensive, scientific action effort in the world to achieve conservation of soil and water resources on a nation-wide scale was undertaken by the United States when the program of the Soil Conservation Service — then the Soil Erosion Service — got under way. From the beginning, one cardinal principle dominated and guided this new land program for a permanent and more fruitful agriculture. Some called the principle idealistic and impracticable and some completely failed to grasp its significance. Farmers, however, after a period of convincing demonstration, generally accepted it enthusiastically and asked for more and more assistance based on the new guiding principle.

This principle was at the outset and is today as follows: *Effective prevention and control of soil erosion and adequate conservation of rainfall in a field, on a farm or ranch, over a watershed, or on any other parcel of land, requires the use and treatment of all the various kinds of land comprising such areas in accordance with the individual needs and adaptabilities (or capabilities) of each different piece of land having any important extent.*

The use and treatment of a given area of land must, of course, be determined not only by its physical characteristics, but also, wher-

ever possible, by such other considerations as available facilities — implements, power, labor, and market facilities — as well as by the preference of the farmer, his ability to learn, his willingness to try new methods, his financial means, size of his farm and location, type of farming he wants to follow, and his persistence.

Furthermore, the land to be treated must be considered in whatever pertinent physical relation it may have to any adjacent or neighboring tract, and to the entire farm, ranch, or watershed.

LANDS ARE DIFFERENT

Anyone taking a trip through the countryside in any part of the United States can see why the conservation principle is fundamental. Some lands are flat or nearly so; some slope moderately and some precipitously. Some lands are sandy and some clayey. Some lands are too wet and some too dry. You can see such facts as to land condition and many more almost at a glance.

There are hundreds of different soils occupying varied slopes and subject to different intensities of rainfall and varying temperature. These numerous kinds of land, occurring under a wide range of climatic conditions, are adapted to a variety of plants, requiring different cultural practices. From place to place — even on the same farm — these various land conditions, subjected to different treatments, result in varying susceptibilities to erosion and losses of rainfall, and consequent variation in productive capacity.

In short, *soil is only one part of land.* The two are not synonymous. *Land,* as it must be regarded by the conservationist and the farmer, *is made up of soil, slope, susceptibility to erosion, and climate.*

It is probably safe to say that no two fields are identical. Accordingly, each field — even each important part of a field, pasture, or woodlot — requires its own particular conservation treatment. Conservation specialists have found that each farm, each ranch, is a special problem within itself — calling for a special job due primarily to the physical environment.

It is the infinite variety in land, and in the diverse performance of wind and water, and in other factors of the natural environment, that rule out simple, fixed formulas for conservation of soil and water. The old, single-practice methods cannot possibly succeed in meeting the wide range of conditions prevailing across the country, or even within a state or county, or on a farm. For example, the South tried for generations to solve its erosion problem by terracing alone. The result was that millions of acres were ruined for any further immediate cultivation. Other parts of the country have relied without success on crop rotations to take care of the land. Rotations have helped out but they have not been sufficient to control erosion. In some localities there was great activity to plant cover crops as a means of keeping the soil in good condition. Each of these measures has a place in soil conservation, but there are very few areas in the United States where they are effective when employed alone. Neither terracing, rotations, cover crops, nor any other single measure is likely to do the job by itself — on land of hazardous erodibility.

To control erosion, conserve water, and improve the productivity of the land, while in use, we must use every appropriate measure at our command in the combination best suited to solve each individual conservation problem as presented by each individual parcel of land.

A NEW AGRICULTURAL TECHNIQUE

Such a comprehensive approach to soil conservation, as now practiced by trained soil conservationists, involves a knowledge and technique in land use and protection never previously employed in any general way anywhere that we know about. This is *soil conservation science.*

This approach is not only the cheapest and most effective way of protecting farm land from destructive erosion, *it is the only practical way to keep cultivated and grazing land permanently productive.*

Until this new system of using adaptable measures, properly co-ordinated, came on the scene in 1933, in the form of the program of the Soil Conservation Service (first under the name Soil Erosion Service), farm lands in the United States were being impoverished at a rapidly increasing pace. The rate and extent of damage by erosion during the 45-year period from about 1890 to 1935 probably exceeded all previous damage to the farm lands of the country. But now, finally, with the aid of this new, rapidly-spreading technique, we are definitely turning the tide; we are steadily winning the fight against the greatest enemy to productive land — uncontrolled soil erosion.

THE FIRST STEP

How is this work accomplished? What are the steps:

First of all, each farm or ranch is carefully analyzed, both as a piece of land and as a business enterprise.

In making the physical analysis to determine the productivity and protection needs of the land, field men of the Service carefully note, on the ground, the exact lay of the land, the quality of the soil, the degree of erosion damage, and the prevailing erosion hazards on every acre of every field, woodlot, pasture, and unused area over the entire farm. As accurately as possible, these conservation technicians determine which lands can be cultivated under good farm practices without excessive loss of soil and rainfall, and at reasonable cost in labor and material; which lands need the protection afforded by special crop arrangements, special tillage practices, or structural installations; and which ones require a permanent cover of trees, grass, or other protective vegetation, as well as what productive use can be made of idle lands. In those localities where irrigation is practiced, specialists are even sent every year into the snow-bearing mountains of the upper watersheds to determine how much water the farmers in the valley below may count on for their seasonal plantings when the deposits of snow melt.

The next step is to work out with the farmer a farm plan for practical operation, based on the ground information acquired and translated into eight simple land-capability classes.[1] This the soil conservation technician does, not indoors around a table, but out in the fields, pastures, woodlots, gullies, and abandoned and idle areas, working along with the farmer himself — with all the pertinent facts immediately at hand on a conservation-survey map of the farm for full insight, understanding, and cooperative consideration.

In some cases, the proposed new arrangements, as based wholly on the physical char-

[1] A short time before the establishment of the Soil Erosion Service (September 19, 1933) Glenn Fuller of the Georgia Agricultural College and the author worked out a tentative method for mapping the effects of soil erosion. Primarily, the method was based on a classification of land types—not soil types. These classes were determined by soil, slope, and degree and kind of erosion. The surveys made at the time showed not only these physical factors but also the broader types of land use. The first work was done in the old plantation belt of the Piedmont section of Georgia, starting on February 9, 1933. (Georgia Land Use Problems. Georgia Experiment Station, *Bull.* 191, May, 1935).

Here was the first attempt on an extensive scale to classify and map erosion conditions in their relation to other physical characteristcs of the land, its agricultural capacity, and its conservation needs. It was also the first time erosion had been mapped under a system which classified both erosion and slope by types. This information, which should have been available long before, immediately provided the basis for a much better understanding of soil erosion, and of the land itself.

The most important result, however, was that this new kind of survey proved extremely useful in planning for the application of complete soil conservation operations, both for erosion control and for bringing about needed, scientifically balanced land-use adjustments, on entire farms. The Soil Conservation Service adopted this system of survey as a basic tool of its integrated action program on the land, and has continued to use it—with occasional refinements.

So it was that in 1939, for the first time in the history of America, we began producing simple maps—generally showing no more than eight land classes, or land-use capability classes—as a basis for planning for effective soil

acter and needs of the land, may not entirely fit the farmer's pocketbook. It may call for more hay crops than he actually needs or can sell. It may not provide for enough potatoes or corn or wheat or tomatoes. It may propose other changes the farmer cannot afford to make. If so, it is not a good arrangement in a practical sense, and must be adjusted or balanced, if possible, to meet family needs and market opportunities — and the farmer's personal preferences. Purely from the conservation standpoint, however, the farm arrangement based on physical land conditions is ideal. The closer the farmer can approach it and still make a good living, the more stable and productive his land will be, and the surer his production, over the long run — and generally for the immediate or very near future.

BLUEPRINTS FOR SOIL CONSERVATION

When the farmer and the technician have come to an agreement on the practical, effective steps that should be taken, the information is incorporated on a map of the farm. Such a map is a basic part of the farm plan for soil and water conservation. It shows:

1. The location of the various important soils.
2. The slope of the land.
3. The degree and extent of erosion.
4. Such features as field, pasture, and farm boundaries; areas of grassland and woods; fences; streams; gullies; roads; cattle lanes; and buildings.
5. The capabilities of each important parcel of land on the farm, on the basis of its conservation needs and productive capacity.
6. Details on what is to be done in every field, pasture, and woodlot of the entire farm, including idle land, gullied land, and land not suitable for cultivation, grazing, or forestry (but which may be valuable for wildlife). It shows, for example, which fields require strip cropping or terracing; which lands are to be planted to trees or hay crops; which lands are to be kept in pasture and which are to be converted to row crops; where dams should be built across gullies; where stabilized waterways must be installed for safe disposal of excess rainfall; and so on.

Blueprinting in this way for the develop-

(*Continued on page 29*)

PICTORIAL

BECAUSE OF the widespread interest in conservation photography, and because good pictures so often tell a story better than words alone, the Journal plans to reproduce on the center pages of each issue the four best photographs submitted to the editor.

Criteria for the selection of photographs will be excellence of composition and effectiveness in presenting conservation information. Insofar as possible, both factors will weigh equally in making the choices.

Members are invited to submit photographs for the picture section of the Journal. They should be accompanied by a complete description of the subject matter shown, as well as any interpretation that seems necessary. For the time being, the Journal will be unable to carry color photography.

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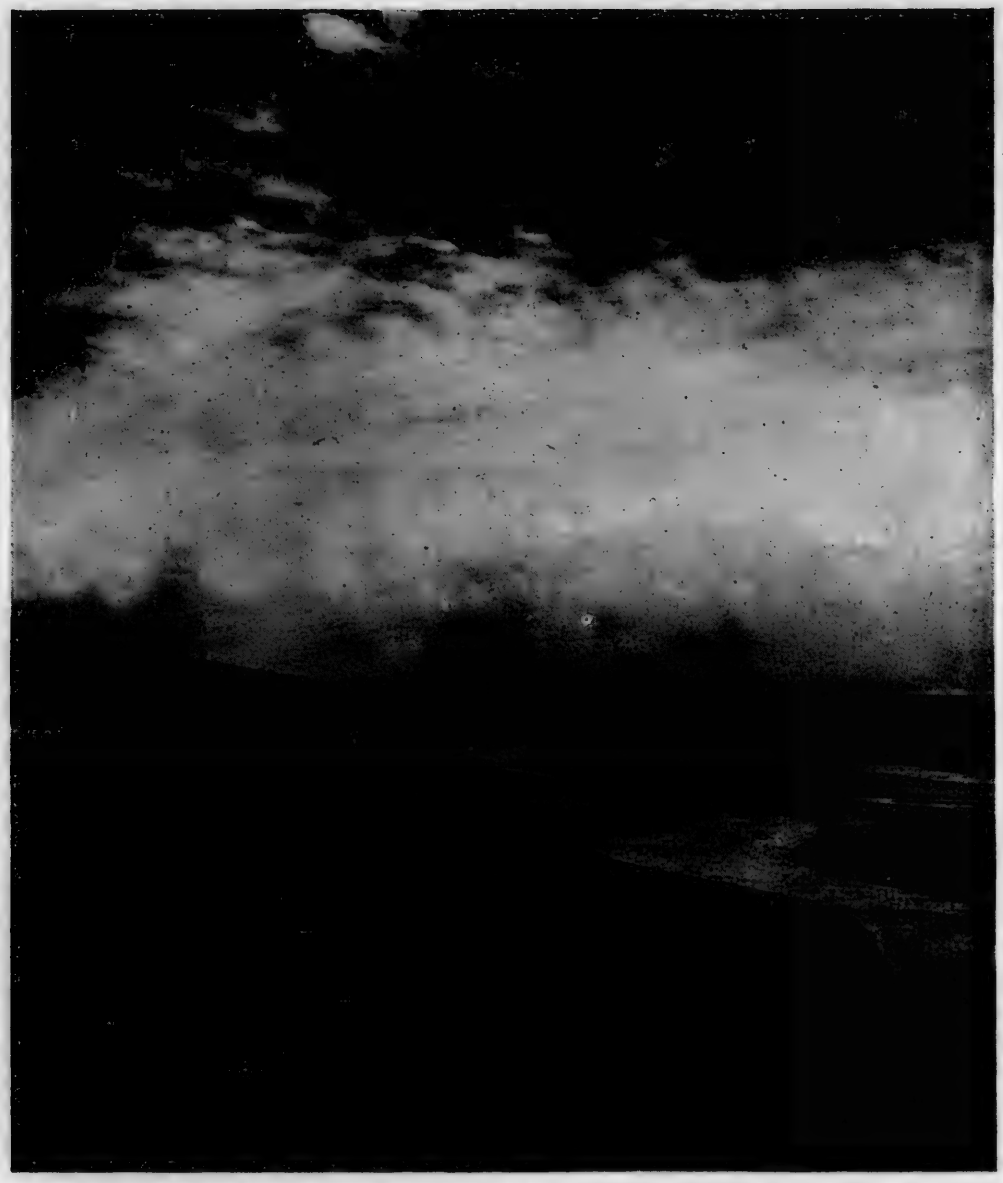
and water conservation. (See: Our American Land. *Misc. Pub.* No. 596, U. S. Dept. of Agr., Soil Conservation Service; and Classifying Land for Conservation Farming. Farmers' *Bull.* 1853, U. S. Dept. of Agr.) The classes range from land of such favorable quality and condition as to require no special treatment for sustained use and for adequate protection against erosion, through land that requires a variety of treatments for efficient and safe cultivation, to land that should never be cultivated under any circumstances.

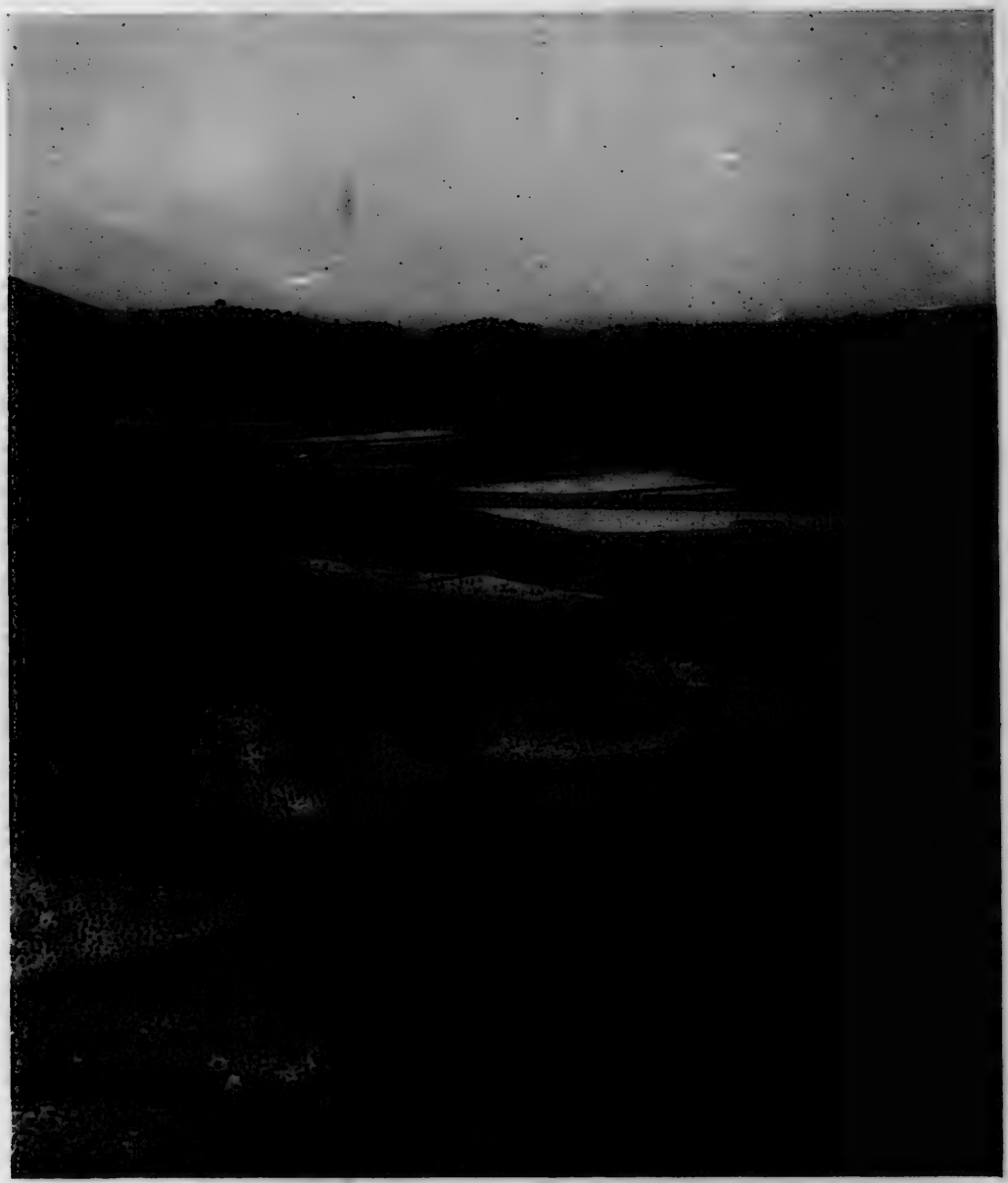
This land capability survey is just the kind of surveys we need in soil conservation operations and land repair work.

Mention should also be made of the nation-wide reconnaissance of erosion carried out by the Service in 1934 and 1935. Previously a partial and very general survey of erosion conditions over a large part of the country was made by the author (The National Program of Soil and Water Conservation. Jour. Am. Soc. of Agronomy, Vol. 23. May, 1931), but it lacked detail, both with respect to classification and distribution of erosion. Until the 1934-35 reconnaissance erosion survey was made (published by the Soil Conservation Service, 1935) there was no source of information in existence that showed in any adequate way the general extent and distribution of erosion throughout the United States or any other country.

Good land use is represented by wooded slopes, strip cropping, and manure piled over a field near Nuernberg, Germany. The photograph was taken in April, 1946 by the U. S. Signal Corps, and released by the Bureau of Public Relations, War Department.



Submitted by the Portland chapter, this picture shows a forty-acre field strip cropped in wheat and fallow. The fallow land was tilled with a rod weeder. The attractive view was photographed by Robert Branstead of the Soil Conservation Service.



Intensive use of land resulting from pressure of human population is vividly portrayed by carefully tended rice fields near Seoul, Korea. The picture was taken last November by the U. S. Signal Corps and was released for publication by the Bureau of Public Relations, War Department.

Harvesting wheat on the crest of a terrace in Franklin County, Kansas. The modern broad base terrace permits the effective use of powered farm equipment needed in growing small grain. The photograph is by R. W. Hufnagle of the Soil Conservation Service.

ment of soil conservation farming is like making a plan to guide the building of a house or the drawing up of specifications for digging an irrigation ditch or installing a fishpond.

SPECIAL PLANNING CONDITIONS

Regional variations in land conditions, climate, and type of farming quite naturally have an influence on conservation planning. In the great livestock range areas, for example, soil conservation takes a somewhat different form than in the farming regions. In range areas, less emphasis normally is placed on basic shifts in land use; stress is greater on protection and improvement of grass through careful management of livestock. Fundamentally, however, the conservation plan on a western ranch is like that on an eastern farm. It is a combination of good land use, appropriate management of land and grass, careful conservation of rainfall, and adequate soil defense, based on the inherent needs and adaptabilities, as well as man-induced conditions, of every single acre.

Planning for conservation on farms where drainage is an important requirement calls for careful consideration of upstream conditions. For example, where open ditches are the best means for draining wet lands, every effort should be made to control erosion on the entire watershed contributing runoff to the drainage canals and ditches, in order to reduce silting to a minimum. This often can be done easier where the watershed lies within the boundaries of a single farm than where it reaches into several farms. Situations of this latter kind necessitate group planning, if the best job is to be done.

In irrigation farming areas, provision should be made for the safest and most effective application of water, in order to control erosion and to avoid water-logging, waste of water, and "scalding" of plants. Also, waste water should be carefully handled to prevent damage to lower-lying lands. Often this can be done advantageously by spreading such waste runoff over neighboring pastures and meadows. A good drainage system, installed before irrigation begins, should be a part of all irrigation projects whether a single farm is involved or many farms.

Sometimes rock lies so near the surface of eroding fields, where it may not be feasible to turn the land over to grass or trees, that blasting is required to provide adequate terrace-channel depth. Exceedingly accurate engineering specifications are called for under such conditions, since rock work of this kind is expensive.

Planning for stockwater ponds calls for careful consideration of hydraulic data and land conditions in order to assure the inclusion of a watershed large enough to provide adequate runoff to keep the reservoir supplied with water. Water-spreading operations, diversion dams, and irrigation of rice fields also require the most accurate information obtainable as well as highgrade application work, in order to avoid costly or inefficient installations.

In regions where wind erosion is prevalent, it is important to study the possibility of using windbreaks or grass, especially on critical areas. Consideration must also be given to the utilization of crop residues, flexible cropping systems, and so on.

In certain glaciated regions, hummocky or hillocky topography sometimes prevents satisfactory use of such measures as terracing, strip cropping, and contouring. Under such conditions, it may be neessary to provide for as much grass agriculture as may be practicable, together with stubble mulching and the growing of small fruits.

Peat lands and peaty-muck lands are so susceptible to burning in dry seasons that every consideration must be given to maintenance of the water level, by pumping and other means of lowering and raising the groundwater level, in order to control fire. The growing of shallow-rooted crops is frequently called for on such lands, and in drainage

operations it is often of the utmost importance not to over-drain the upstream source of water, such as marsh lands that will be needed to draw upon in dry seasons for proper maintenance of water levels.

Whatever the condition or the region, the end product of soil and water conservation blueprinting is an arrangement of fields, pastures, meadows, woods, ditches, etc., that safeguards the soil and fits the land as nearly as practicable in accordance with the requirements of Nature. Such an arrangement constitutes an adjustment in land use that most nearly accords with the physical environment. Together with the adapted conservation practices, it makes up the complete farm plan, with operations duly balanced for effective soil and water conservation and a successful agricultural enterprise. Under such a plan, soil conservation is not just an incidental bit of the mechanics of farming; it becomes part and parcel of the whole business of making a living from the land.

TOOLS OF SOIL CONSERVATION

Since soil conservation is the proper protection, use, and care of land, so that it will produce the greatest amounts of the products most needed, while at the same time protecting the land from loss of productivity, all measures that help keep land in a condition favorable to sustained production are, therefore, tools of conservation. Terracing, contouring, strip cropping, use of organic matter, grass, legumes, shrubs, trees, crop rotations, fertilizer, lime, drainage where the land is too wet and irrigation where it is too dry — all of these and whatever else is needed are conservation tools that are utterly indispensable to getting the job of soil conservation properly done.

These tools are sometimes used singly where the land is easy to stabilize, but they are more often used in combination, one supplementing another, where the conservation needs are more difficult or complex. In other words, *soil conservation includes any and all measures that will in any way increase the productivity of the land and cause the land to keep on producing satisfactorily.*

This is my definition after 43 years studying the land throughout the United States and various other countries. It is based on research, surveys, and experience of farmers and grazers throughout the world.

WHO DOES THE WORK?

In order to apply a completely balanced program of conservation farming to a farm — in its entirety — it is necessary to combine the techniques of all the pertinent branches of the agricultural sciences. A single farm may require engineering, agronomic, hydrologic, biologic, geologic, chemical, and other skills in the process of conserving its soil and water resources.

Normally, however, these skills are not needed separately; on the contrary, a combination or *synthesis* is most often required. To meet this requirement, a new vocation was developed. It is a direct outgrowth of the national soil conservation program. In the person of the *soil conservationist* the nation now has a professional worker whose greatest value lies in his personal proficiency in several agricultural sciences and in his ability to bring this knowledge to bear, in proper proportion and perspective, on the everyday farm problems of soil and water conservation. To put it another way, the *soil conservationist* is a practical technician—a *soil conservation scientist*—capable of recognizing the ordinary needs of land for conservation of soil, water, and productivity, and who also has the ability to apply skillfully — scientifically — the various conservation techniques either singly or in combination, as needed.

For efficient forward movement of the national program of soil and water conservation, however, there will always be a need for well-

trained specialists. There will always be a need for agronomists, geologists, engineers, foresters, botanists, hydrologists, and others—in addition to soil conservationists. These specialists are needed to help keep soil conservationists, working directly with farmers, fully abreast of the latest developments in the various technical fields and to help train new soil conservation personnel. The specialists are also needed as constantly available consultants for the soil conservationists, whenever and wherever abnormal or highly complex problems of soil and water conservation must be solved.

Take away from our national program of soil conservation any one of these techniques or technicians and you thereby weaken the conservation effort of the nation — and the nation itself. You impair the effectiveness of the work. You retard progress. You jeopardize the chances of controlling erosion. Today, by using all the needed techniques, technicians, and specialists, we are controlling erosion on an increasingly widespread scale.

Occasionally, some people who do not understand very well the requirements for achieving effective and lasting conservation work on the land propose that agronomists should not work on the soil conservation job because they are agronomists, not soil conservationists. Once in a while, the same type of mind will suggest that engineers should not be used because they have been trained to do strictly engineering jobs. They sometimes even advance the idea that foresters should not be used because they have specialized in forestry in and out of college. Once in a while, this strange kind of thinking takes another turn in the form of notions that conservationists should not build terraces or plow on the contour because that is "engineering," or plant trees or any other needed plant that grows in the earth because such work is "forestry" or "agronomy." That kind of thinking is silly. If it were to prevail, there would be no practical way, no possibility, of ever getting the conservation job done.

FIELD OF ACTION

Fortunately, the quibblers and the sticklers who, either willingly or unwittingly, would thwart the national conservation program, will not prevail. They are but a very tiny minority; the vast majority favor the program.

Teachers, industrialists, students, doctors, union members, ministers, bankers, editors, legislator, and farmers — people in every walk of life — have endorsed the soil conservation program and given their support to it. Most enthusiastic, of course, have been the farmers themselves. Rather slowly at first, but with ever increasing vigor and certainty, more and more farmers have taken up the cause of soil conservation not only on their own lands, but as champions of this better kind of farming among their friends and neighbors. The greatest preachers and advocates of soil conservation in our country today are the farmers who have tried it.

Soil conservation has taken on the stature of a nation-wide agricultural movement. One powerful factor in this movement is the soil conservation district. Late in the summer of 1937, Arkansas passed the first soil conservation district law. Since then, 47 other states have passed similar laws, which permit — and usually encourage — farmers to band together in districts for a cooperative, group, or community effort to stop erosion and conserve the soil and water resources of their own locality.

With this aid from their state legislatures, farmers responded quickly. They have now organized more than 1,600 soil conservation districts, taking in more than half of the agricultural area, and more than half of the farms and ranches of the Nation. With each passing month, farmers organize new districts or enlarge the boundaries of old ones. To my knowledge there has never before been a voluntary farm program that has so rapidly captured the enthusiasm of farmers, or one that

has attained such widespread popularity. There is no question about it; farmers want to do soil conservation work and they like soil conservation districts.

The constantly increasing interest of American farmers in soil conservation is shown by the manner in which they are speeding up the organization of their soil conservation districts. Between April 15 and May 15, 1946, for example, 55 new districts were voted, and the acreage of these new districts and of additions to previously organized districts in the same period totaled more than 29 million acres. That means that our farmers were setting up their soil conservation districts for this period at the rate of nearly two districts and a million acres a day.

Aside from the popularity of this program among the great rank and file of farmers, the soil conservation program being carried forward through the medium of locally organized and locally operated soil conservation districts has already compiled a record of laudable accomplishment. The soil conservation districts of the country are action districts. They do more than talk and hold meetings. They plan and push and work to obtain the actual application of well rounded programs of soil and water conservation on the land itself. This involves more than single farms; it involves all the farms in entire watersheds, often large watersheds. With the assistance of soil conservation technicians, it involves the application of carefully planned soil conservation farming over the entire district.

Districts are getting the job done. Soil conservation districts are succeeding in their objectives. In the beginning there were many skeptics. There was talk that they wouldn't work. But they have worked, and are moving ahead rapidly. There are some very good reasons why they have worked. I would say there are eight primary reasons, although there are others.

Soil conservation districts are succeeding because:

1. They are typically American, in that they provide a means for mutual action toward common objectives as determined by the majority.

2. They are independent. Their destinies are not controlled by outside influences, either State or Federal.

3. They exist for action. Their whole being is directed toward positive accomplishment.

4. Their work is founded on widespread local understanding. When farmers learn the facts about the land and agriculture in their district, they can agree on a united course of action and carry it out with every reasonable prospect of widespread satisfaction. Moreover, districts usually bring together as supervisors, by popular election, the leading farmers or landowners of the various localities, with the result that some of the best thinking in each community is regularly interchanged with that of neighboring communities.

5. They are definite organizations that are able to plan programs, obtain information, procure governmental and other services, and do many other things that the same farmers as individuals, working alone, would not have been able to do.

6. They provide a recognized centering point and clearing house in the locality for carrying forward advanced agricultural programs and developments, in general, from weed control campaigns to group drainage projects, as they are in the best interests of soil and water conservation and proper land use.

7. They provide a practical medium through which the encouragement, influence, and assistance of local business and professional interests can be brought to bear in an effective, constructive way for the benefit of agriculture in the district.

8. They are in a position to provide helpful local guidance, responsive to the needs and desires of the local people, to such professional workers as the county agent, soil conservation technician, forester, and highway engineer.

THE BEST IS YET TO COME

Soil conservation districts will continue to grow in number, area, and accomplishment as the years go by. They will become an ever more powerful influence for the protection and improvement of the nation's natural resources. Along with others, the Soil Conservation Service will be their ally. The national soil conservation program will succeed. The signs are all good and the best is yet to come.

Each year the program is speeding up. Last year work was completed on 13 million acres in soil conservation districts. That was 2,800,000 acres more than we did the year before, and much more, proportionately, than we had done in any single year. Moreover, it was accomplished at a time when we were restricted on transportation facilities, manpower, and everything else. We were able to do this, as already pointed out, because of the splendid way soil conservation districts are taking hold of the job, with everybody working together.

Thorough soil conservation treatment, acre-by-acre, on the basis of complete farm conservation plans, has now been applied to some 40 million acres in the hundreds of districts with which the Service is cooperating. (Treatment of another 36 million acres was completed under the demonstration program preceding the formation of districts.) This is not all the work the Service has done by any manner of means; it has surveyed many millions of acres in soil conservation districts to provide adequate guides for future soil conservation work. It has helped soil conservation districts develop district plans and programs. It has stood ready to answer conservation questions for all of the 3,800,000 farmers living in soil conservation districts. And it has done additional constructive work that cannot be given in detail here.

In 1943, 8,931 typical farmers throughout the country — who keep books on their operations — reported, as the result of their use of conservation methods, per-acre increases in yields for the major crops grown throughout the country averaging 35.7 percent. This means that every three acres farmed the conservation way produced, in 1943, more than four acres farmed the old, wasteful way. Our best estimate, based on these and thousands of other farmer reports from all parts of the country, is that *soil conservation gives at least a 20 percent increase in yield, with the increases beginning, usually, the first year after the practices have been applied to the land.* Such an increase is the practical equivalent of adding to our crop-producing area productive land amounting to one-fifth of the land in cultivation. And this is much like discovering a very large area of new agricultural country.

The assistance of the Soil Conservation Service to farmers in soil conservation districts cost the public $1.70 an acre last year. This cost covered all the work which the Service did for planning and application to the land in districts, for all research and survey work (both of which will be valuable far into the future), for everything that was purchased (from postage stamps and writing paper to automobiles and everything else), and for all transportation, all travel, all overhead, and all other expenses of every kind. I put this up as the lowest per-acre cost for effective operations that has ever been achieved by any agency working on the land to maintain its productivity.

A STATEMENT

The area of good crop land is shrinking everywhere. The population is growing. Pressure on the land is increasing correspondingly. With each passing year our own nation, and the world we live in, will be forced to look more and more to its land for the sustaining things of life.

The day will come when the combination of productive land and water will rank second only to people as the most important of all resources. Meanwhile, all conservationists must carry on unfailingly in their efforts to stop erosion. Time is getting shorter. Those

who would thwart the progress of conservation, for whatever purpose, are in this day and age the enemies of mankind. They should be promptly discredited.

We must maintain an adequate area of productive land. That is an area, throughout the nations of the earth, which will be sufficient to produce at least a minimum nutritional diet for the population of the world. This is the least that common sense — and self perservation — requires. How will this be done? Is there an alternative to the kind of soil conservation program I have described?

I know of only two: outright and absolute governmental regulation on the use and treatment of all lands, or despicable abandonment of hope. Which of these three do you prefer?

Ancient Irrigation on New Caledonia

EDWARD B. BALLARD

EDWARD B. BALLARD is a landscape architect and served as a camouflage officer during the war. He is now associated with the National Recreation Association.

SCIENTIFIC BOOKS often mention the *tarodières* or terraced hillsides of New Caledonia with reference to the irrigation schemes of uncivilized races.

In early times the warring cannibals of this South Sea island, that lies a thousand miles northeast of Sydney, Australia, were skilled agriculturists as well. In the words of Gilbert Archey, Director of the Auckland War Memorial Museum in New Zealand,[1] they found that "careful cultivation and irrigation are a necessity in this not too fertile land, which quickly parches in the dry season." So they grouped the bark-roofed huts of their *tribu* on the banks of streams, he writes, "with close-cut sward, well-ordered plantations, and ridged and terraced cultivations, watered by little rills, led across them from the mountain brooks." Besides the usual coconut, yam and banana, a common food of the natives was taro, which requires a plentiful supply of water around its roots. It was the extensive cultivation of this root crop which caused the construction of irrigated terraces on the hillsides.

With stone-edged tools the natives dug these terraces and covered the slopes of whole stream valleys with them. Unlike the hillside rice paddies of the Orient, *tarodières* were only three to four feet wide. According to H. E. Lewis Priday, in his book, "Cannibal Island,"[2] the natives "used to bring water long distances in irrigation channels and bamboo pipes." It was these channels that watered the evenly-terraced hillsides and kept the broad, pointed taro leaves growing luxuriantly through the dry months.

The rounded, grass-grown terraces of long-vanished agricultural communities give mute evidence that New Caledonia once supported over 200,000 natives, when Captain Cook "discovered" the island in 1774. Today the natives number less than 30,000. Irrigation works built by the *indigenes* of an earlier time are quite different from the gardens of present-day inhabitants. Some of these modern agricultural plots are cultivated in vertical rows up and down the hillsides, accentuating sheet erosion and drying up in mid-summer. Contour terracing is practiced on a few hillside farms, but the lesson of water conservation learned centuries ago by the untutored savages is not generally recognized by the present-day population of this sub-tropical French colony.

[1] *South Sea Folk, Handbook of Maori and Oceanic Ethnology*, 20th October 1937.

[2] *Cannibal Island*, the *Turbulent Story of New Caledonia's Cannibal Coasts*, A. H. and A. W. Reed, Publishers, 182 Wakefield Street, Wellington, New Zealand, 1944.

BOOK REVIEWS

THE LAND RENEWED—By William R. Van Dersal and Edward H. Graham. New York: Oxford University Press. 1946. 110 pp. $2.00.

TWO DISTINGUISHED authors now offer this first adequate primer in soil conservation. *The Land Renewed* equally balances text and pictures. Each illustration appears only after exhaustive research and consideration. Each facing page of explanation is vivid and concise. I know of no better, quicker and more agreeable way to become acquainted with the ills of the land and their cures than an evening with *The Land Renewed*.

Drs. Van Dersal and Graham do a good turn both to the public and to fellow scientists in reducing "The story of soil conservation" to its simple essentials. At the same time, they spin a capital yarn which is likely to be reached for eagerly by high school lad, clubwoman, lawyer, mechanic, and fireside browser. *The Land Renewed* races through fifty-odd topics—"chapters" in any orthodox book—in little more than fifty minutes flat. It proceeds from the forest primeval to the soil conservation district modern. My preference would have been for text at left and pictures at right, rather than the reverse, and for halftones rather than off-sets, but publishers decide such matters of format according to their own crystal ball, and somehow manage to keep in business.

The Land Renewed holds to the theory that democracy is rooted in the soil. It remarks, "We do not yet know how much American land could produce if every bit of it were used exactly right. But we do know that this great quantity of land is the key to the power and freedom of our nation." And again, "It is fitting that the people of this nation should have been waging war to protect their freedom at the same time that they have started another to save the land. Freedom, like the soil, is most appreciated when it is endangered."

The business of the American patriot, obviously, is to know this American soil, its hazards and its needs. With the aid of soil conservation's new Baedeker—*The Land Renewed*—he readily interprets a broken ditch wall as a soil profile, while his mentors describe the chemistry and life and meaning of topsoil. He visits, too, the scenes of erosional crimes—a gully, a wasted hillside, a sediment-filled reservoir, a flooded village, a dust storm—and learns the answers to his startled "Why?" He finds, even though he never turns a furrow himself, that his personal stake is high when he is assured that he and his neighbors may go on shorter rations unless America acts boldly and in time.

What can be done? Yonder is a farmer plowing 'round a slope. *He* knows, says the guidebook. That's contour cultivation.

Another farmer strip crops. A third terraces. Here's a windbreak, there's a hedge. Another page, and the topic is stubble mulching.

Thus, two by two, move pictures and prose. Thus moves soil conservation's kaleideoscope: practices, soil-holding plants, cover crops, rotations, wildlife borders, woodland management and range management. The American motorist learns the importance to his travels of roadside drainage and grassed shoulders. He meets a new kind of scientist along the way—a soil conservationist who may once have been no more than an agronomist, a forester or an engineer. As he approaches the end of his tour, he encounters "Democracy in Action" — in other words, that lusty new phenomenon, the soil conservation district. And now he begins to tie everything together—research, farm planning, techniques, and grass-roots democracy — all moving to change

for the better the pattern of agriculture. Every citizen can help the thing along if he but understands what is happening to the soil resource, and what must be done. He *does* understand after reading this book.

The Land Renewed departs from precedent. It is to be hoped that it presages other books, in similar vein, by this top team of ecologists from the staff of the Soil Conservation Service.

—WELLINGTON BRINK

SOIL EROSION IN NEW ZEALAND: A GEOGRAPHIC RECONNAISSANCE — By Kenneth B. Cumberland. Whitcombe and Tombs, Ltd., Wellington, New Zealand, 1944. 227 pp.

NEW WORLD TO WIN — By C. J. J. Van Rensburg and E. M. Palmer. A. C. White, P. and P. Co. Ltd., Bloemfontein. South Africa. 201 pp.

EROSION IN THE PUNJAB: ITS CAUSE AND CURE—By Sir Harold Glover. Civil and Military Gazette, Ltd., Lahore, India. 1944. 143 pp.

EL HOMBRE Y LA TIERRA — By William Vogt. Secretaria de Educacion Publica, Mexico City. 1944. 94 pp.

JOURNAL OF THE BRITISH GRASSLAND SOCIETY, Volume 1, Number 1 — By Dr. H. I. Moore, Editor, Penglais, Aberystwyth.

THE PROFESSIONAL soil conservationist will be interested in several excellent treatments of erosion and land-use problems published in other countries during the past couple of years. Outstanding among them is *Soil Erosion in New Zealand: A Geographic Reconnaissance* issued by the Soil Conservation and River's Control Council. There are 60 plates and figures, glossary, bibliography and index. Four appendices treat geology, climate, soils, and vegetation in their relation to erosion. A fifth summarizes the New Zealand Soil Conservation and River's Control Act of 1941. A colored and folded map, reprinted from the Geographical Review (31:4, Pt. II, 1941) shows cultural vegetation and land utilization with inserts depicting primitive vegetation—as found in 1840—rainfall, relief, locations, and forest types. Additional maps show geology, soils, erosion regions and other features. Many of the illustrations graphically depict erosion in the islands, and the bulk of the book is given over to treatment of accelerated erosion in relation to geology, original vegetation, land use and other influences.

To the American soil conservationist one of the striking features of the book is the revelation that many of the erosion-control practices proven so effective in the United States are of comparatively little use in New Zealand. This is in part because our methods have been most intensively developed for areas of tillage agriculture and are not suitable to New Zealand which is 75 per cent grassland and pasture, 16 per cent forest and brush. Furthermore, the types of erosion found are peculiar to the islands. There is large-scale slipping of mountain slopes, subsurface tunneling, earth creep, slumping, mud flows, shingle slides, and explosive avalanches that burst out on such a scale and with such violence that they trap and bury sheep. More than two-fifths of the area of the Dominion is "inflicted with the disease of culturally accelerated erosion to a degree which justifies national concern."

An attractive little book of pocket size entitled *New World to Win* has just appeared from the pens of C. J. J. Van Rensburg and E. M. Palmer. The book is intended as a primer of land use for South Africa, but the professional reader in this country will learn a great deal that is new from it. The 201 pages of text are sprinkled with half-tone illustrations and the chapters are short. The book contains a challenge to the youth of South Africa upon whom will fall "the task of exploring this world and so making possible health and strength for all and a great and fruitful future for our nation." There is a big job to do because droughts, dry rivers, bare velds, dongas, dust storms, pests in the crops, lean animals and starving people, say the authors, "warn us that we are not working with, but against, the

laws of Nature." How familiar this sounds to us and how well it proves the widespread need for a more naturalistic approach to land use.

The book then treats food, especially the kinds of food that are needed, soil and water, the balance of nature and how it was altered through use to create the South Africa of today. There follows a discussion of how to use the land wisely, with chapters on veld management, contour farming, crop rotation, how to make the soil rich, and so on. There is a chapter on tree planting, another on vegetables, fish and honey. The book closes with other chapters on Nature's pattern, planning a farm, and agricultural clubs. At the end there are two full-page facing photographs. One is a deep, vertically walled donga or gully; the other a big city street. The legend is: Remember—this (the donga) is your problem too.

That use of land has caused world-wide concern is further proved by a book from India entitled *Erosion in the Punjab: Its Cause and Cure* and subtitled *A Survey of Soil Conservation.* The first part of the volume describes the Punjab—a large area of alluvial plains south of the Himalayas in the northwestern portion of India that is drained by the Indus River and its tributaries. The author, once Chief Conservator of Forests for the Punjab, says that "the fundamental causes of the erosion of the soil are economic: the population of the Himalayas and of the submontane tracts is greater than the land can support." It seems that this is ecologic rather than economic, but the primary relationship is one every soil conservationist must recognize. Is good land use sufficient if population is not controlled? In the Punjab the population has increased 40 per cent in the past 20 years.

Environmental conditions are described in the first part of the book, and there is discussion of causes, effects, and methods of curing erosion. The second part of the work is the longer. It treats nine districts, describing general conditions for each and discussing what is being done toward proper use of the land. Unlike most of South Africa and New Zealand, this region has been heavily used for a long time. Once forested hills are now badlands, ravines (gullies) are a common sight, and in some sections "hundreds of thousands of fields" have been washed away. It is surprising to learn the number of practices being demonstrated and established to help hold the soil of the Punjab. Terracing and embanking cultivated fields to hold rainfall, reduction of livestock to carrying capacity, afforestation, drainage, consolidation of fields sub-divided by inheritance, reclamation of chos — torrential stream beds — and many other practices are described and illustrated.

If you read Spanish you may enjoy a little volume, *El Hombre y la Tierra,* by William Vogt, Chief of the Conservation Section of the Pan-American Union. This booklet is intended for popular reading and school use throughout Mexico and is No. 32 of Biblioteca Enciclopedica Popular. It treats fundamental principles underlying the relation of man to the land, the hydrologic cycle, and other ecological ideas fundamental to an understanding of the land and its proper use. Although non-technical, the book is of interest to soil conservationists as further example of the interest being shown in this field throughout the world.

It is fitting to recognize in this first issue of the JOURNAL OF SOIL AND WATER CONSERVATION, the appearance of Volume 1, Number 1 of the *Journal of the British Grassland Society,* published under the editorship of Dr. H. I. Moore, Penglais, Aberystwyth. An attractive publication, the first issue of the Journal appeared in March 1946. It is of considerable moment that even in England, where we often think that use of the land has reached a degree of balance with nature, the British Grassland Society was born of "the brotherhood of endeavor which has been responsible

for the turning over and under of so many millions of acres of permanent grass." In the words of Sir R. George Stapledon, its President, the Society is formed of "men who are specialists in all the sciences embraced by the elusive term 'agricultural science,' who are actively apprenticing themselves to what almost amounts to the new science of grassland." In our own Soil Conservation Society of America we might easily substitute the words soil conservation for grassland in a parallel statement. The first number of the new British Journal carries articles on output of pasture and its measurement, role of silage in grassland management, occurrence of a specific insect in reseeded grassland, and productivity of reclaimed areas.

—EDWARD H. GRAHAM

(Book Reviews continued on page 50)

EDITORIAL

(Continued from page 2)

concerned, which is so essential to world peace. This situation presents a challenge—unequalled in history—to the professional soil conservationist. The task ahead, needless to say, is big and complex. Are we equal to the need and the opportunity?

The Chicago Meeting

SOIL conservationists will welcome the opportunity to attend the Society's Annual Meeting which is scheduled to be held in Chicago, December 12-13. President Ralph Musser, in preparation for the meeting, appointed a committee to develop a program for presentation to the council. The committee has been unusually active, and reports indicate that the meeting will be of great interest to the membership.

This is the Society's first general meeting. Matters pertaining to its organization, its policies, its objectives and the presentation of Chapter needs, will undoubtedly occupy an important place on the program. There will also be speakers—recognized as leaders in the profession—to bring the membership of the Society up-to-date on technical and general soil and water conservation problems that are worldwide in scope. This is truly an opportunity for the soil conservationist to broaden his experiences. He will meet many members from other sections of the country with whom he can exchange ideas and help make the Society a vital factor in his professional field.

Soil Conservation Is a Profession

SOIL and water conservation is a profession based on the application of soil erosion-control methods, water conservation measures, and sound land-use practices. The work of the professional soil conservationist is predicated on research, the synthesis of many agricultural sciences, and years of effort in its application on the land.

The professional soil conservationist now, for the first time, is confronted with new and greater responsibilities. His profession is basic to the needs of society. He must recognize and provide for its development, its refinement, and the improvement of its standards. He should give encouragement to research and experimentation; to the preparation of original papers on soil and water conservation; to participation in scientific and general meetings; and to freely mingle with workers in other fields for the mutual exchange of knowledge, experiences, and ideas. All this he cannot do alone. He must be supported by the combined efforts of all soil conservationists in every walk of life working together as a team.

The columns of the JOURNAL belong to the membership of the Society and should reflect the thinking of the professional soil conservationist. It should champion his cause and provide a means through which he can give expression either for or against an issue. This, in our opinion, is essential if we are to forward the science of soil and water conservation and improve a profession that is fundamental to the welfare of mankind.

A Message from the President

TODAY, LAND use and soil and water conservation problems are of great importance to people throughout the world. Needed facts and knowledge about these problems can and must be gained through research and its evaluation. Educational methods for the dissemination of these findings must be attractive, effective, and challenging to those who use the land. They must also interest and inspire the citizenry at large, rural and urban, young and old. All are dependent on the sustained production of the land. And everyone should come to understand that widespread and more rapid action is necessary in the application and maintenance of soil conservation measures on the land if we are to avoid a serious reduction in our capacity to produce.

Through the advancement of soil and water conservation science, and through active participation in other work of the Soil Conservation Society, members can accomplish much toward meeting these needs. It is worth emphasizing that the best of soil conservation research is of little value unless its results are applied to the land. Facts and findings must be understood by the men who are to apply them. Through our educational facilities, the men who use the land must be informed and inspired to use it wisely and maintain it — in productive condition — for all time.

As I see it, active participation in the work of the Society can become a most rewarding pursuit. It can be the means of helping to improve the lot of human beings, both at home and abroad. It can become a source of real personal satisfaction. And clearly, there must be active participation on the part of the members if our Society is to grow and serve as it should. To encourage this activity, the policies and administration of the Society must at all times be fully representative of all the interests of the membership.

Let there be enthusiasm and diligence on the part of the members and the influence and benefits of the Soil Conservation Society will be great and far reaching.

H. H. Bennett

Membership of the Society

THE membership of the Soil Conservation Society of America is made up of more than 1,700 professional conservationists representing private industry, colleges and universities, state, federal, and other agencies. Included in the membership are many employees of the Soil Conservation Service. This Service, as a government agency, is a constructive and vigorous force in the field of soil and water conservation. It is probably natural that many of the Society's members in these early years are Soil Conservation Service men. This need not be a permanent condition, nor is it necessarily desirable. If the Society is to fulfill its purpose, it must include in its membership all those who are professionally concerned with the science of soil and water conservation and sound land use.

The Society as a professional organization recognizes among its members those who are trained to promote and advance all phases of the science of the conservation of soil and water resources. It recognizes teachers in the field of conservation, agronomists, agricultural engineers, foresters, biologists, drainage and irrigation specialists, soil scientists and surveyors, hydrologists, research workers, and many others.

Ramdom Notes About Water

ALMOST all of the water used from day to day, in agriculture and industry, and by individuals in town and country, comes first in the form of rain or snow falling on the land. Until it hits the earth's surface, there is no practical control over it. Thereafter, however, the water from rain and snow is subject to control by man. How to manage this water, use it, and dispose of it, affects everyone—the people of the towns and cities as well as of the farms and ranches. Everyone must have water to drink. Water is a part of the food needed. Water is a source of power. It is essential to agriculture and also to business and industry.

Water conservation—including the proper management, use and disposal of water—therefore, is of vital concern for it touches the lives of people directly or indirectly; it affects city and industrial water supplies, farms and ranches, through drainage, irrigation, flood control, and in other ways.

Three Water Problem Areas

Water falls as rain or snow on almost two billion acres of land in the continental United States. On all of this land, wise management of water is needed. A billion and 60 million of these acres are farm or ranch land, so farmers and ranchers are primary custodians of the Nation's water supply. The balance of the land in the continental United States is divided approximately as follows: private forest land, 433 million acres; national forest land, 178 million acres; public, state, municipal, and other land, 234 million acres.

There are no fine lines of demarcation between natural water areas; various parts of the country, however, can be grouped into three main natural water areas. They are: first, where there is a normal supply of water; second, where there is too much water; and third, where there is too little water. This simplified grouping, while subject to many technical exceptions, enables one to obtain an overall view of the three main water problem areas in the United States.

The normal water supply areas of the Nation embrace about 1,800 million acres. Some control is needed on this land to help prevent floods and siltation and aid rural, urban, and industrial water supplies. In addition there is need for considerable soil and water conservation work such as terracing, reforestation and other practices upstream, as well as work on stream banks, stock ponds, etc.

Areas With Too Much Water

There are approximately 127 million acres of land in the United States with too much water. About 96 million of these acres have never been cleared for farming or opened for the cultivation of crops. Some day, part of this land may be cropland, but most of it—at least 78 million acres of it—is not suitable for farming according to our present standards. Some of it produces high grade cypress timber. However, most of this area will serve best when left as it is, in its natural state, for the preservation and the propagation of wildlife.

Today, on the farms of the nation, there are some 29 million acres that are either too wet for full production or too wet for any production at all. At one time or another, all of this land has been farmed. Some of it is still being farmed. However, with too much water on top of the land, or too much water in the soil itself, results are rarely worthwhile. It is not producing food, fiber, feed, and grazing as it should. In addition, there are approximately 8 million acres of irrigated lands in the West needing drainage to control the water table and prevent damage from alkali salts.

There are an additional 20 million acres of wetland, never cleared for farming or opened

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Notes and Communications

Soil Conservation Society of America

IN A RECENT discussion of the new Soil Conservation Society of America with a prominent soil scientist, a number of points were raised, some of which may be worthy of further consideration and clarification. This scientist's immediate reaction was one of concern regarding the existing organizations in closely allied fields of endeavor, such as, the American Society of Agronomy, Soil Science Society of America, Friends of the Land, etc. Further discussion brought out what seemed to be a clarification of the position of the new Soil Conservation Society of America in relation to the old established organizations. Briefly, the conclusions reached were as follows:

1. The Soil Science Society of America is primarily concerned with *fundamental research* in the soils although currently considerable emphasis is placed on what might be termed applied research, some of which deals with soil conservation.
2. The new Soil Conservation Society should be primarily concerned with *applied research and operations* in soil and moisture conservation. As such, it should deal with the application of fundamentals of engineering, range, forestry, agronomy, soils, etc., and their integration into a program of soil and moisture conservation. A certain amount of *applied research* is considered essential in achieving this objective.
3. Friends of the Land has membership consisting largely of professional people in other than agriculture (doctors, dentists, teachers, writers, etc.) who have a sincere interest in furthering the public's obligation in conservation. Members may be said to have a patriotic or possibly a "hobby" interest in conservation. (This may be an entirely inadequate statement of the position of Friends of the Land as I am not a member).

I believe it desirable to have a clarification of the position of the new Soil Conservation Society of America in relation to other established organizations in order to assure a rapid and healthy growth. Are the above thoughts, though brief and inadequately expressed, in line with the current thinking?

—LEONARD WOHLETZ

Tree Growth Related to Physical Conditions of the Land

AS A NATION, we have arrived at the threshold of acknowledging timber trees as a crop — a product of the soil, like wheat or potatoes.

During the past decade, millions of acres of forest land have been certified as "tree farms." These lands, in ownerships both large and small, have been dedicated to the growing of a forest crop. Other millions of acres will continue to be dedicated to this same purpose. It is a progressive movement of tremendous significance.

Recognition of the need for giving nature assistance in growing a forest crop demands a greater knowledge of the relationships between the tree and the soil from which it gets food. It is also essential that these relationships, when determined, be expressed clearly and simply, so that the average forester and other agriculture workers will know them and use them.

The amount of forest land in the United States is far greater than that now producing a commercial crop of wood. As the conservation objective of making every acre fully productive of the crop or crops to which it is best suited is more and more nearly attained.

the present uses of much of our land will necessarily be changed. Some of the land now growing a forest crop will be cultivated, and some will be used for pasture. Dr. Wilson Compton, President, Washington State College, recently said of the Pacific Northwest, "Much of its growing land is useful only for growing timber." He could have said the same thing of the entire country.

If the forest landowner is to continue paying taxes and fire protection costs, controlling insects and diseases, and providing good land and crop management generally, he must vitally concern himself with the productive capacities of each acre for a wood crop and for adapted alternate crops. For those lands which are now producing a commercial timber crop, we can make estimates of growth rates. These data may be, and generally are, expressed as timber site classes. However with the trees absent, or the stand impaired, the forester is not equipped to evaluate the timber productive capacity of potential forest land.

An adequate classification of the land itself, indicating its productivity for wood as well as for alternate crops, is essential to a determination of the benefits involved in such courses of action as:

1. Clearing the land of trees and using it for crops or other intensive purposes.
2. Planting the land to trees and management for the production of a forest crop.
3. Applying intensive forest management practices, except planting, to produce a forest crop.

The need for a correct decision in the first instance is quite obvious to those acquainted with the fact that population pressures, in the Pacific Northwest at least, are causing present forest land to be cleared for cultivation. There can be little objection to such a land-use change, provided the land is suited to growing a cultivated crop and the economics are sound.

A determination in the second instance involves economic considerations which are as essential to good land use as are the physical. For example, it is generally agreed that, at the present time, the average landowner can profitably plant Douglas fir on the three highest timber site classes. The returns from the timber crop do not justify the costs of planting Douglas fir on Sites IV and V.

The third item is extremely important. There have been many failures to get restocking following logging even though what are known as good silvicultural practices were followed. It is quite possible that a large percentage of those failures were due to lack of consideration of such factors as soils, slopes, exposures, and in the case of Douglas fir, soil-moisture relationships. We must recognize that it is necessary to move with greater caution when dealing with borderline cases, whether physical or economic.

In May, 1944, during the soil conservation survey of the Lewis County Soil Conservation District, Washington, data also were gathered on stands of second-growth Douglas fir. Our purpose was to determine what degree of correlation existed between the utilitarian soil groups as mapped in this survey and the timber sites. Among the more important features considered, were: kind of soil, its depth and texture, its moisture and nutrient resources; erosion; degree and direction of slope; altitude; rate of tree growth; and past use of the land.

Our preliminary analysis of these data shows a high degree of correlation between utilitarian soil groupings and Douglas fir sites. That is, on any given soil group, all fully stocked stands of Douglas fir grow at practically the same rate. Consequently, in Lewis County where these relationships have been established, we have found it possible to use conservation survey data as a responsible index to the advisability of planting trees for a future timber crop, of clearing and converting to crop production and other intensive use, or of applying good management to a naturally restocked forest.

—T. B. PLAIR

PROTECTING STORAGE RESERVOIRS

(*Continued from page 20*)

stallation of the program must be weighed against the benefits. Often the combined benefits to the land (on-site) and to the reservoir (off-site) will justify a complete program where neither the landowner nor reservoir owner separately could achieve the higher degree of conservation that will adequately serve both ends.

Relation of Factor

Now, let us put these several factors together and see what sort of picture we get. Figure 3 shows a range in watershed areas from 0.01 to 1,000,000 square miles plotted against the C/W ratio. Making the assumptions stated below, the lower wavy line represents the practical limiting zone below which reservoir silting cannot be controlled by soil conservation on the watershed. This limit depends on three factors: (1) the rate of sediment production, including the ratio of coarse to fine sediment. In this chart a rate of one acre-foot per square mile has been assumed. (2) The trap efficiency of the reservoirs; and (3) the length of time required for completion of a soil conservation program on the watershed. In this illustration the time for completion of a program was assumed to vary from three years for areas of one square mile and less, to 15 years for 1,000 square miles and more, with no effect before this time limit and 100 per cent effect thereafter. This gives the same result when applied to extension of the life of the reservoir as if it were assumed, more in keeping with the facts, that a progressive increase in effectiveness will occur over twice the period. The lower line will, of course, change position with variation in the factors that control it.

The higher wavy line representing the upper limit of benefits is controlled by three eco-

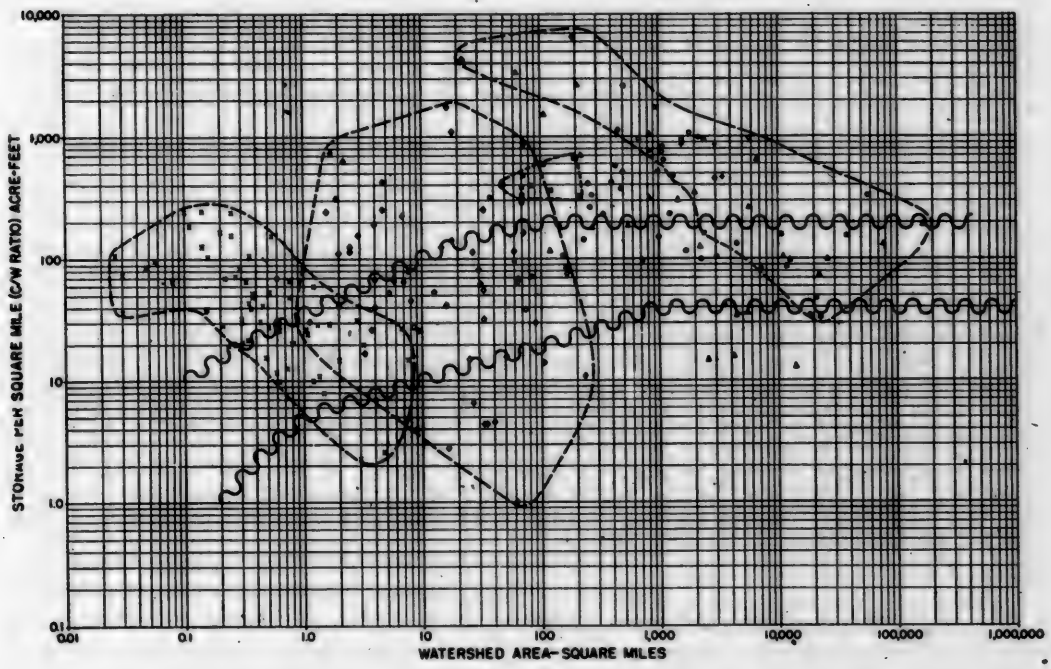


Figure 3

Range of possibilities for reservoir silting control by watershed conservation programs.

nomic factors: (1) the relative value of dam sites as determined by their abundance and demand for the services which their utilization can provide; (2) the pressure of the discount rate; and (3) the cost of the soil conservation program. This line is based on the premise that economic benefits from protection of the reservoir must warrant a substantial proportion of the cost of the watershed treatment program. The conditions vary so widely that, for any particular reservoir, this limit may be 25, 50, 75, or 90 per cent of the total cost of the program. Let's look at it in this light. Suppose the ten square-mile watershed of a municipal reservoir is entirely within a going soil conservation district. For the district as a whole, with present facilities—education, planning, and application will proceed at a certain rate. Giving no more attention to the reservoir watershed than to any other part of the district, the conservation program, which is designed solely for agricultural benefits, will reduce sediment inflow to the reservoir 20 per cent in ten years. Suppose it is physically possible, however, to reduce the sediment load 75 per cent after five years thus extending the reservoir's useful life from 25 years to 85 years (useful life 60 per cent; silting rate 2 per cent; age five years; time of application five years). The city considers how much money will be required to accomplish this objective in comparison with the sinking fund payments required to build a new reservoir at the next best site 25 years hence. In other words, how much is the city justified in spending to supplement and expedite the landowners' conservation program in consideration of benefits accruing from extension of the life of the reservoir, and of alternatives for maintaining the required storage or comparable services.

This is conventional economic logic. It is the type of logic that has been applied in the Department of Agriculture's flood control surveys to evaluate benefits to downstream resources from a soil conservation program on the watershed. It follows the same basic principles used by the Army Engineers, who allow no monetary benefit from extension of the life of any flood-control project at maximum operating efficiency beyond 50 years.

This principle is certainly subject to debate, for it takes no account of social and political values, which are inherent in public works involving natural resources, as contrasted with private investment for private profit. The larger the reservoir — the larger the segment of society it serves — the more non-substitutable the service — the more irreplaceable the reservoir site — the less such economic reasoning can be justified. In my opinion, when an economic analysis shows that we can afford to spend only $29 per year to protect Bridgeport Reservoir in the Trinity River watershed, then such economics does not adequately guide nor reflect national policy but rather perverts our thinking to a false concept of the value of our natural resources.

It is a matter of record that many reservoir owners instinctively share my opinion. Numerous examples could be cited of watershed conservation—particularly land purchase and reforestation—that has been undertaken by reservoir owners, both public and private, even though the foregoing type of economic analysis would have clearly shown the much greater financial gain from investing the same amount of money at 3½ per cent interest to replace the reservoir at some future date. In other words, practical business men time and again have laid their dollars on the line for long range benefits to the Community, — benefits which are still considered intangible assets by many government experts.

Let us look now at the distribution of certain types of reservoirs. Remember that we are dealing with the average soil conservation district program and are assuming a conventional economic analysis. In Figure 3, the line on the lower left encloses a group of 70 typi-

cal stock ponds in five counties in Kansas. About one-third of them lie between our limiting lines. Only two are below the physical limitation. These were built ten years ago and are probably now completely silted. The second large enclosure includes 57 municipal water-supply reservoirs in the Southeastern States. Only eight of them fall below the line of physical limitation, but 17 are well above the economic line. More than half of them, however, offer excellent opportunities for effective sedimentation control through soil conservation by any standards. The small enclosure bounds all of the headwater flood-control reservoirs in the Muskingum River basin, Ohio. The upper enclosure surrounds 44 of the Nation's largest reservoirs or two-thirds of all our reservoirs which have more than a half-million acre-feet of storage. Excluded in this group are reservoirs downstream from other large reservoirs and those which are basically natural lakes. With one or two possible exceptions we can physically protect all of these reservoirs, but only 15 of them or one-third are within the conventional economic limit.

CONCLUSION

In conclusion, let me offer three recommendations:

First, for those reservoirs that fall well below the physical line, as computed for the particular reservoir, let us not delude the reservoir owners or ourselves about the possibilities of soil conservation. Let us, instead, assist him in storage conservation by recommending, and helping him to develop, the numerous other practices for silting control such as sluicing, dredging, by-pass canals, etc.

Second, for those reservoirs that are within the range of benefits, let us proceed vigorously to educate the reservoir owners to cooperate in the soil conservation program. Let us make a directed and concerted effort to get his support—let us plan to do it—not incidentally, but purposefully. Let us concentrate on this in due proportion just as strongly as we do on selling conservation to the farmer and rancher.

Third, for those reservoirs that fall above the conventional economic line, particularly the group of major reservoirs on the upper right, let us develop a realistic economic outlook, and a methodology for its expression, which will take into due account the social as well as the entrepreneurial values of these indispensable, irreplaceable and non-substitutable natural resources. Let our economic research catch up with our physical research. Then let us vigorously campaign for the protection of these vast developments.

Regardless of whether agriculture moves in the direction of more corporation farms, more cooperative farms, or more individual family farms, the productive land must be conserved. Neither a corporation, a cooperative, an individual, or a government can bring land back, once it is at the bottom of the Gulf of Mexico or the Indian Ocean.

The annual difference in runoff between an average virgin acre and an average eroded acre, multiplied by the total number of eroded acres, represents the approximate total increase in annual runoff attributable to erosion.

With a constant population, every time erosion wipes an acre out of production anywhere in the world, it increases the pressure on every remaining productive acre. With a growing population, the pressure is compounded.

The only political faith in the science of soil conservation is the political faith of humanity.

S.C.S.A. Committee Reports

Publication and Editorial

THE REPORT of this Committee is told best by the publication you now hold in your hands, for the production of the Journal has been its primary task. If the Journal is not entirely to your liking, be tolerant. The Committee can take responsibility for presentation; it cannot determine the kind and quality of material presented. That is *your* responsibility. The Committee is proud of the contributions it has received. Some could not be included because of space limitations — they will be printed later. Remember, however, that future issues depend upon the participation of Society members, either in contributing directly or in getting others to submit appropriate material.

The publication policy of the Society has not jelled, and should never be inflexible. If you have an idea that may help the Journal, write the Editor, and write him now. The Committee hopes that the Journal will become an important medium for stimulating thinking and doing in the science of soil and water conservation. It can only become such a medium if you will make it so.

The Committee wishes to thank those who have helped conceive the Journal. The officers of the Society, the publisher, Bill Pryor who designed the cover, the advertisers, and all of you who have contributed material have our perennial gratitude, To the Editor we pay special tribute. Walter Gumbel is well qualified by every standard for the chore he has graciously agreed to perform. The Society owes a debt to the Monongahela Power Company for permitting Mr. Gumbel to undertake the task, which is time-consuming.

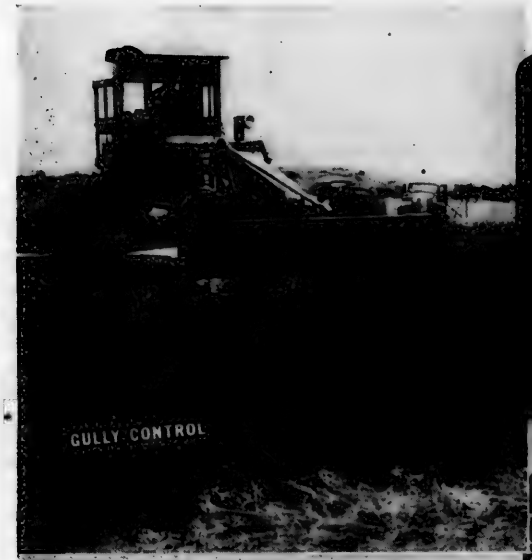
The Committee is convinced that the Journal has an important niche to fill in the complex of professional endeavors that contribute to the welfare of people. We hope you will help to make the Journal the outstanding publication it must be if it is accurately to represent the enthusiasm and progress that are inherent in the work of the professional soil conservationist.

—EDWARD H. GRAHAM,
Chairman

First Annual Program

The Program Committee for the First Annual Meeting of the Society was appointed by President R. H. Musser on August 11, 1945, with the following members: S. W. Cosby, Verne Davison, W. M. Nixon, Victor A. Surface, and Gladwin E. Young. The President expressed the assignment in these words: "The duties of this committee, as I see them, are to plan the program for the next annual meeting of the Society and be responsible for the subject matter on the program (refer to item 16, 'Meetings,' in the by-laws)."

The committee approached its assignment on actual program formation by considering the general type of meeting that would be most appropriate—should there be mostly presentation of papers by individuals or should the program be built mainly around round-table discussions. Furthermore, the committee also considered allotment of time for field tours or inspections and for business sessions. These types of considerations were important at the outset in determining the total duration of the meeting, recommendations for location, and actual content of subject matter.



There's a JOB to be done

EROSION—robbing the "good earth" of its rich top-soil—has totally ruined one-fifth of the original area of tillable land in the United States. About one-third of the remaining tillable land is already badly eroded, and more than half of the rest is subject to erosion.

Yes, there's a job to be done! Lots of earth to be moved. Graded Channel Terraces, Level Terraces and Diversion Terraces to be constructed. Waterways and Outlet Ditches to be built. Gullies to be filled. Drainage Ditches to be dug.

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BUILDERS OF ROAD MACHINERY SINCE 1859

Austin Western

It was decided that for the first annual meeting no field tour or inspections would be included. The committee does believe, however, that in subsequent years field tours may have an important place on the program. It was further decided that the meeting should cover three days, with two evening sessions. It appeared desirable to devote one half-day and one evening to strictly business affairs of the Society. The entire committee leaned heavily in favor of the round-table discussion type of sessions for presentation of most of the subject matter topics to be included on the program. It was agreed that a strong paper on a topic such as "Soil Conservation In Our Democracy" would be very fitting at the outset of the meeting. Everyone agreed that a "Founders" banquet should be arranged and Dr. H. E. Bennett should address the gathering.

The program was developed around four major topics, with three of them regarding The Science of Soil Conservation: namely, (1) Its Foundation, Development, and Scope, (2) Its Understanding and Acceptance, and (3) Its Application. The fourth topic concerned technical phases of soil and water conservation.

The committee made its major report to the Council just prior to its April meeting. Topics and names of participants were included in detail. The Council ruled that the annual meeting should be confined to two days. This, of course, automatically limited the night sessions to one. The Council's decision also presented an added and somewhat difficult task for the committee, namely, to condense its proposed program and at the same time retain the important features. This was accomplished, however, to a considerable degree except that far less time will be devoted by the attending membership in general to business matters. The revised program as recommended by the committee was submitted to the President.

In addition, the chairman, acting on behalf of the committee, visited several hotels in Chicago and obtained information on facilities and accommodations. The Council had determined that the meeting should be held between December 2 and 14 and that Chicago was the first choice for location. The information on hotels was carefully compared and recommendations were made, according to wishes of the Council, to the President, Mr. Musser. With his concurrence the hotel was selected and arrangements were consumated for the first annual meeting to be held on December 12 and 13.

The committee fully appreciates that many desires as to content of program could not be met during a single two-day meeting. Its members have diligently endeavored to provide for the type of objective and unbiased program content which will help lay a firm foundation for fruitful progress of the Society in years ahead.

—MELVILLE H. COHEE
Chairman

The day of the uneducated peasant and the superstitious hayseed on the land is bound to end. With each succeeding year, the farmer will ascend to an increasingly responsible position in society, for he will be recognized as the custodian of the world's most vital natural resources — the survival resources — productive soil and water.

Who can say with any certainty that the atomic bomb is a greater threat than erosion to the future of civilization?

Even a hybrid seed will not thrive in eroded soil.

Some scientists are like squirrels. They hide their findings.

CONTOURING *Saves the Soil*

Product of INTERNATIONAL HARVESTER

FARMALL TRACTORS—"A," "B," "H" and "M"—and the great variety of McCormick-Deering Farmall equipment add up to make the "Farmall System of Farming." Great things are coming in the Farmall System—just as fast as we can produce them. Let your International Harvester dealer know your needs. Keep in close touch with him.

THE language of Agriculture changes year by year. It is a *working* language that adjusts itself to the coming of new methods, new operations, and new machines.

These days every good farmer has need for words that describe the control of erosion and the conservation of soil—such words as *farming on the contour . . . terracing . . . strip-cropping.*

Yes, America is learning a simple fact—*we must hang onto the thin layer of soil in which our prosperity is rooted.*

Soil conservation is a duty of the nation, actively served through the state colleges and the Soil Conservation Service of the U.S. Department of Agriculture.

Soil conservation is a problem for every individual farmer. It is a duty, a problem, and *a challenge for International Harvester.*

See your local SCS representative, the county agent, the vocational agricultural teacher, and your International Harvester dealer for cooperation in your terracing, contouring and strip-cropping program. They will help you make the most effective use of your Farmall Tractor and your McCormick-Deering Plows and Tillage Tools as weapons in the fight to hold onto your productive soil.

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INTERNATIONAL HARVESTER

RANDOM NOTES ABOUT WATER

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for the cultivation of crops, that are altogether suitable for bringing into production through drainage.

The total, then, is approximately 57 million acres suitable for drainage. The primary area of activity is in the 37 million acres of wetland that have already been utilized, at one time or another, for farm production. The secondary area is the 20 million acres of wetland not yet cleared for farming or opened for cultivation.

AREAS WITH TOO LITTLE WATER

Areas with too little water embrace about 50 million acres of land, where in addition to soil and water conserving practices, much irrigation work can be done. Approximately 20 million acres are now being irrigated by either primary or supplemental irrigation on the farms of the Nation. An additional 30 million acres, which by conservative estimates, based on careful research, could be brought into production if potential water supplies were used with maximum efficiency. Water is the great determining factor and its wise use is most important. Other economic factors, including present and potential domestic and foreign markets for crops must also be taken into account in determining the economic feasibility of bringing much of this new land into production. But the land is there—some of it enormously rich land—rich for farming and rich for grazing livestock. It will take a lot of hard work—irrigation work—to get it into production. And obviously, it will take a lot of water.

Water is life to the soil, particularly in the West. Without water, there are millions of acres in the arid West (roughly west of the 99th and 100th meridian) which cannot produce. There are millions of these acres which are mountainous and there are millions on which some dryland farming is possible. It takes an average of 4 to 5 acre-feet of water per year throughout the West to produce crops. However, with proper water conservation practices —in this case better methods of irrigation— it would be possible to save from 30 to 40 percent of the water now being used. This water could then be applied to other land now "under ditch" or to new land not now producing food.

BOOK REVIEWS

(*Continued from page 38*)

FOOD OR FAMINE: THE CHALLENGE OF EROSION — By Ward Shepard. Macmillan. New York. 1945. 225 pp. $3.00.

Ward Shepard had a potent hand in the transfer of the Soil Erosion Service, launched in 1933 by Harold L. Ickes, John Collier and Hugh Bennett, from Interior to Agriculture and in shaping the Soil Conservation Act of 1935. Ten years later, in the Year of the Atomic Bomb, Ward Shepard in *Food or Famine* looked back over the decade's progress, found it good and charted a course in national and world-wide soil conservation that is good medicine for every worker in soil conservation and for everyone who wants his children and grandchildren to enjoy three square meals a day.

Hugh Bennett dramatized the menace of erosion so effectively that Ward Shepard's book needed only to present a summary of the global activities of this Public Enemy No. 1 and to present some of the post-war implications before undertaking an analysis of the current erosion-control campaign and outlining a course of action for the future. Shepard emphasizes the success attained by the soil conservation districts and suggests the organization of primary land management districts to cover the entire land area, with fusion, coordination and simplification of the functions of all agencies now concerned with land use. He proposes programs based on river basins and stressing the protection of the watersheds, correlating watershed protection with the construction of the main-stem multiphase dams so as to prolong the useful life of these structures. In the analysis and proposals he does not hesitate to smash several of the presently popular icons.

Shepard, I believe, is overly apologetic in his

(*Continued on page 52*)

CONSERVATION
Calls for Selling

HOW fast America adopts soil conservation measures depends mainly on how well and how widely the merits and rewards of conservation are sold. Only when the idea is sold to the point of arousing action does conservation come to reality.

This Company believes in selling a good idea by showing how equipment can be used to put the idea into practice. Such selling gets action, not merely academic acceptance. Hence the promotional and educational activities of this Company seek to sell the USE of tractors and implements for making conservation improvements and for farming by conservation methods.

Case advertising has urged soil conservation measures in a well-rounded program of advanced farm practices. Case has prepared a series of full-color sound movies, plus a parallel series of attractively printed educational booklets and wall charts promoting these practices. All are freely available to any agencies who can put them to good use.

Some of the subjects are pond building, contour farming, terracing with moldboard and one-way disk plows; also the production of high-protein hay which paves the way for grassland farming and soil-saving rotations. You are invited to send for sample booklets and for full information on films, posters, and other educational material.

J. I. Case Co., Racine, Wis.

CASE

District Governing Officials Form Organization

REPRESENTATIVES of soil conservation district governing bodies from 17 states, meeting in Chicago on July 24 and 25, organized the National Association of Soil Conservation District Governing Officials. A temporary board of directors was formed with the following members: Allen Craig, Springfield, Ohio; Fred A. Prell, Bremen, Kansas; W. A. Groom, Grand Junction, Colorado; Dennis F. Getchell, Limestone, Maine; R. M. Boswell, Kenedy, Texas; E. C. McArthur, Gaffney, South Carolina; and R. L. Rutter, Ellensburg, Washington. E. C. McArthur was elected temporary president and R. L. Rutter temporary vice-president by the Board.

The new national association proposes to further soil and water conservation on farm and range land by helping local district governing bodies to do a better job of directing the work of the soil conservation districts.

Its purposes are: To facilitate the exchange of information, knowledge, and experience among district governing bodies; to collect, compile, and disseminate among its membership information relative to the effective functioning of soil conservation districts; to further the functioning of state associations or other organized groups of district governing bodies; and to advance generally the effective operation of districts.

According to the constitution adopted in Chicago, a council composed of one member from each state will elect a board of directors to govern the affairs of the association. Members of the council, directors and officers will serve without pay. At the first meeting of the council, it will elect a permanent board of directors for the first year which in turn will elect a president and vice-president.

BOOK REVIEWS

(*Continued from page 50*)

discussion of the costs of soil conservation and his proposals for financing the programs on a self-liquidating basis. The nation is spending many billions on structures to control floods and aid navigation without asking the beneficiaries to return the cost to the Federal Treasury. If the application of conservation practices and plans will pay for itself and produce a profit for the private-land owner, the cause of soil conservation is that much to the good. If it does not return a pecuniary profit, the nation must still insist upon these practices and plans for its own survival. The cost to the nation of the conservation process, spread over infinity, will be microscopic compared with the indefinite continuation of the land user's ability to pay taxes.

Food or Famine is well worth a close reading by the workers in the field of soil conservation—and the author of the volume welcomes comments, be they brickbats or bouquets.

—WALTER V. WOEHLKE

Soil conservation has grown out of its swaddling clothes. The time is past when you could say erosion is bad and conservation is good — and let it go at that.

Who is hurt most when a Chicago dentist buys a dry sodland in Colorado and has it plowed and planted to wheat? The dentist? The county? Colorado? The nation? One thing is certain: nobody benefits.

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